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NEW YORK, JANUARY, 1889.

THE new dynamite gun-boat, *Vesuvius*, has proved herself a very fast vessel. On a recent trial trip in Delaware Bay she ran a distance of 4½ miles at the rate of somewhat over 21 knots an hour, after making the necessary deduction for tide error, and showed her ability to keep up this rate of speed for a considerable distance. Both the speed and the horse-power developed by the engines on this trial exceeded the requirements of the contract, and there is no doubt that the vessel will be accepted, although a further official trial is to be made. The *Vesuvius* has a pair of triple-expansion engines driving twin screws, and supplied by four cylindrical boilers, which are intended to be worked under forced pressure when the vessel is run at full speed. On the trial mentioned, she developed a total of 3,746 indicated H.P. with her two engines, the piston speed being 873 ft. per minute and the working pressure varying from 144 to 162 lbs. The revolutions of the engines at full speed ran from 260 to 268 per minute.

THE meeting of the American Economic Association, which was to begin in Philadelphia, December 26, promises to be a very interesting one. It is to be noted that a considerable part of the session was to be devoted to railroad questions, the programme including papers and discussions on Railroad Statistics, Railroad Rates, and kindred topics. This is not strange, however, when we consider how large a space the railroad occupies in our modern political and economic system.

Another interesting subject for discussion was road legislation in the various States. It is to be hoped that this will attract general attention, for there is, perhaps, hardly anything more in need of reform than our present system of building and maintaining highway roads.

AN interesting little contest in the matter of speed is now going on between the Pennsylvania and the Baltimore & Ohio railroads. Up to November 18 last the quickest time made between Philadelphia and Washington on regular trains was by the Pennsylvania's fast express, which ran through in 3 hours, 25 minutes. On that date the Baltimore & Ohio changed its schedule and ran two fast trains each way, on which the time was reduced to 3 hours, 15 minutes. A few days thereafter the Pennsylvania also changed its time, reducing it to 3 hours, 10 minutes, but on December 9 the Baltimore & Ohio again cut down the running time, making it this time an even 3 hours. Up to date the Pennsylvania has not followed its rival, but will presumably do so. The distance by the Baltimore & Ohio is 134 miles; by the Pennsylvania it is 137.8 miles; but the four miles' difference is more than made up in time by the ferry transfer across Baltimore Harbor, which is required on the Baltimore & Ohio line.

Under the old time-table the average speed of the Pennsylvania train was 43 miles an hour, without allowing for stops or for any delay in passing through Baltimore. Under the latest time-table, if we deduct the time required for the ferry transfer, the Baltimore & Ohio trains must make an average time of somewhat over 50 miles an hour, which is the fastest time ever scheduled for a regular train in this country. The only stops made by these trains between Philadelphia and Baltimore are at Wilmington and Newark, while between Baltimore and Washington there are no stops at all. From Locust Point, Baltimore, to Washington the run is made in 50 minutes, the distance being 41.8 miles, which is certainly very fast time.

How much further this competition is to be continued we do not know, but it has apparently almost reached its limit. The Baltimore & Ohio has, by the way, called its fast trains the "Flying Yankee" and the "Senatorial Express." The first seems to be appropriate enough, but the second is hardly well chosen, in view of the somewhat slow and deliberate method of proceeding of the exalted body after which the train is named.

AN important engineering work now in progress in New York is the sinking of the tracks of the Harlem Railroad through the Annexed District north of the Harlem River. This is an expensive work, involving some careful engineering, especially as the new line is to be built without interfering with the old or with the almost continuous passage of trains over the old tracks. By it all street grade crossings will be done away with for some four miles, through a thickly settled and continually growing section. The advantage to adjacent property will be considerable, but there will be a still greater advantage to the railroad in the ability to make faster time and in the avoidance of accidents.

In this connection attention might again be called to the fact that a better crossing of the Harlem River than the existing bridge is desirable, and will, in fact, be almost a necessity in a very few years.

CONSIDERABLE progress has been made on the new tracks of the New York, New Haven & Hartford Railroad between New Rochelle and Stamford, and part of them will be brought into use early in the present month. The new work has been very substantially done, and in many places has amounted to an entire relocation and rebuilding of the road, grades being reduced, curves taken out, and the line generally straightened and improved. Between New Rochelle and the junction with the Harlem Railroad at Woodlawn the road has been almost rebuilt, and the new tracks will be a great improvement on the old line.

Stone ballast has been used, with rails of heavy section, and the new tracks will represent the latest improvement in the construction of road-bed and superstructure.

The New Haven Company, although a very rich and prosperous company—perhaps for that reason—has always been considered very conservative and slow to make improvements, but it is now doing a great deal of work on its line at other points also. On the Shore Line Division much work has been done in preparation for a second track, and many improvements have been made in the way of filling in pile-bridges, cutting down grades and similar work.

With the completion of the Thames River Bridge during the present year, and the consequent doing away with the troublesome ferry transfer at New London, faster time will be possible over this road, and it is likely to become the best rail route between New York and Boston.

THE financial collapse of the Panama Canal Company has come somewhat sooner than was expected. Notwithstanding the great efforts made to urge it, the subscription for the new issue of bonds proved to be a failure, the number taken being less than was required by the terms of issue to make the subscription binding, and the Company has come to the end of its available funds. The interest on one issue of its bonds, which was due on December 15, was not paid, and further defaults will probably follow as other interest payments accrue. The Company has applied to the French Government for aid, but it is not probable that anything will be done in this direction. The amount of the Company's stock and bonds, which are held almost entirely in France, and by small investors, is so great that there is some fear of the failure causing a financial crisis in that country, but it is not likely to affect others in any considerable degree.

The consequences to the work now in progress on the Canal will, of course, be disastrous, and there seems to be no alternative except that of stopping the work and leaving it in the condition in which it at present stands; but in a tropical climate work like that which has been done on the Canal will not remain in a stationary condition, and the half-finished excavations will deteriorate very rapidly, and should the stoppage be permanent, will disappear entirely in a few years.

Already there is talk of the reorganization of the Canal Company, and various plans have been proposed, but it will take some time to work out any definite plan, even should one be possible. The latest intelligence is that the affairs of the Company will be for the present in the hands of a provisional committee representing the creditors and stockholders.

A STRONG movement is at present on foot in favor of the purchase of the Swiss railroads by the State, although Switzerland is the last country in Europe where one would expect to find the State railroad system in favor. The Swiss lines have, in general, been fairly profitable, although from the nature of the country several of them have been very expensive roads to build and to work. The line of largest traffic, which is also the most profitable, is that from Zurich to Luzerne, which last year returned nearly nine per cent. upon the capital invested. Some of the smaller lines have, however, been worked at a loss, but last year the average return of all the Swiss railroads was about three per cent. on the stock. The working of these mountain lines requires unusual care, and it has apparently been exercised. The accident list last year included only two persons killed and 89 injured, more than half of these casualties having resulted from the carelessness of the injured persons themselves. Two new lines of some interest are in progress, an extension of the mountain section of the Brunig Railroad and the new Pilatus road, a mountain line on Mount Pilatus.

THE official returns of the Indian railroads show that at the close of last year there were upon the 14,065 miles then open a total of 3,364 locomotives, 8,825 passenger-train cars, and 61,219 freight cars. The increase of equipment was hardly proportional to that in mileage, but large additions will probably be made during the current year. The number of employés at the close of the year was 225,047, which is somewhat higher proportionally to the mileage of road than is found in this country. It is interesting to note that the proportion of Europeans employed on the Indian railroads is gradually decreasing. At the close of 1887 they formed only 4.34 per cent. of the total, the remaining 95.66 per cent. being natives. Even of this 4.34 per cent. classed as Europeans only about one-half come properly under that designation, the remaining half being of European descent, but born in India. The principal change in natives employed during the last year was in engine-runners, in which class there was an increase of nearly 10 per cent. of the number of natives.

An important question, which has always considerably affected the expenses of the Indian railroads, is that of fuel; this is being gradually solved by the opening and development of the coal-mines of the country, and the locomotive expenses are very largely dependent, as might be expected, upon the proximity of the lines to these mines. Thus, on the East Indian Railway, where the coal used comes principally from the company's mines on various sections of its line, the cost of fuel was only about 80 cents per ton, while on the Great Indian Peninsula Railroad, which uses largely English coal, with some wood, the average cost of coal was $4 per ton and the locomotive expenses were naturally very much higher. The East Indian Railway is worked at about as low a cost as any railroad in the world, and the cheap fuel has had a very important part in permitting a constant reduction of expenses.

THE old project of a ship canal to connect the Volga and the Don rivers, and through them the Caspian and the Black Sea, has been revived, and is to be undertaken by a Russian company in which a number of French capitalists are interested. The actual length of the canal will be 54 miles, and the cost, including some river improvement works, is estimated at $20,000,000. The great drawback which has always been urged against this project is the dangerous and difficult navigation of the Sea of Azof, through which ships must pass to reach the mouth of the Don.

A WRITER in a recent number of the Vienna *Zeitschrift für Eisenbahnen* calls attention to the fact that the railroad system of Europe is practically completed, in the sense that—outside of Turkey—it is no longer possible to build any new main or through lines which will not parallel existing lines, or which are at all likely to pay interest on their cost. This explains the great interest lately shown in several European countries in the building of cheap branch lines and feeders to the main lines, and such

railroads are for the time furnishing an outlet for the capital seeking investment in this direction. This field is comparatively a limited one, however, and will soon be filled, so that the disposition to invest in foreign railroads will probably receive a considerable impulse.

For more than a generation past railroads have been a favorite form of investment in almost all civilized countries. The amount thus absorbed has been enormous, and any check to continued demand will be felt in many ways. Of course the building of railroads is not at an end by any means, but in Europe the stage of completion has been nearly reached, and future additions will be each year a smaller percentage of the existing mileage.

The field for future railroad investments will be in Asia and Africa, where there is plenty of room for railroads, but where their building must depend on colonization, the introduction of European ideas, the growth of commerce and many other considerations, both commercial and political. The opening for capital will be great enough, but will have too much of the element of risk to suit the many who prefer the safety of a home investment.

It may be questioned whether we are not, in this country, approaching the European condition. East of the Mississippi—perhaps of the Missouri—it is hard to find where a new through line could be profitably placed, and in some sections even the building of branches has been overdone. Competition is already excessive, and any present increase would hardly be a benefit to the country. Population, wealth, and production are growing here more rapidly than in Europe, but the railroads have grown faster than all, so that they must, in many cases, wait for the growth of the country up to them before their owners can look for even moderate returns.

LOCOMOTIVE FIRE-BOXES.

IN the design and construction of locomotives there seems to be a tendency toward uniformity and similarity in every other part excepting the fire-boxes. There appears to be some influences at work which lead to very wide differences in the forms and proportions which under very similar conditions are adopted for these. Thus there are engines running with boilers originally built for the narrow (3 ft.) gauge, and which have since been altered to run on the standard gauge without changing the fire-boxes. Their grates are only about 18 in. wide and 6 ft. long, so that the grate surface is about 9 square feet. These engines, it is reported, make steam freely, notwithstanding the small size of their grates. The late Mr. Brooks, when he was on the Erie Railroad, at the time it was changed from a 6-ft. gauge to 4 ft. 8½ in., said that the engines which were altered and which had the fire-boxes narrowed seemed to steam as freely and economically with the narrow as they did with the wide grates.

The other extreme of locomotive practice is the Wootten fire-box and others of similar construction with grates 8 ft. wide and 10 ft. long, with a total of 80 square feet of grate surface, or nearly nine times as great as that of the altered narrow-gauge boilers. It is true that most of these boilers with excessively large grates burn anthracite coal, but bituminous coal is burned in some of the Wootten boilers, as on the Chicago, Burlington & Quincy Railroad, and is said to give excellent results.

If we compare the height of fire-boxes, a similar wide difference in practice will be found. Thus the distance from the top of the grate to the under side of the crown-sheet, on ordinary passenger engines, is about 6 ft. In fire-boxes which are placed on top of the frames the height is about 4 ft., and in some of the Wootten fire-boxes from 2 to 2½ ft. In the Strong locomotives the fire-boxes consist of corrugated tubes of 38½ in. smallest diameter. These comparisons are made with engines of different weights and dimensions, but all of a heavy class, so that there is enough similarity in their capacities to be able to contrast the diversity of practice which exists in the construction of their parts. In view of this one cannot help asking, in the language of the humorist, "Why is this thus?" Which is the best, or which gives the most economical results, the small grate or one nine times as big? Apparently the locomotive superintendents and master mechanics of the country have no satisfactory answer to give. If there was any very material difference in the economy of large grates compared with small ones it seems as though the fact would have made itself obvious in the practical performance of the engines which have large grates. If, on the other hand, engines with small grates burned less coal than those with large ones, it seems inconceivable that the phenomenon should not have made itself obvious in the coal accounts of some roads. That the superiority of large over small grates, or *vice versa*, has not been clearly recognized would seem to lead to the inference that the size of the grate is of little importance. Before accepting this conclusion, though, the fact should be noted that, with the present form of construction of locomotives, if the grates are made large, the fire-boxes must be shallow. The reason for this is that when the fire-box is widened it must be put either above the frames, or if, as in the case of the Wootten boilers, they are made wider than the space between the wheels, they must be put above the wheels, which necessarily reduces the height measured from the top of the grates to the crown-sheet. There are locomotive superintendents—Mr. Lauder, of the Old Colony road, for example—who contend that a shallow fire-box will burn bituminous coal as economically as a deep one will. But all the shallow fire-boxes in use, excepting those in the Strong engine, have also been wide—that is, they have been placed on top of the frames, and thus made the full width of the space between the wheels, or they have been of the Wootten type. Now it may very possibly be found that additional width or length will compensate for lack of depth. Part of the Wootten patent is for the use of a combustion chamber with a wide grate, so as to add to the cubical space inside the fire-box. The cubical contents of a deep, narrow fire-box may be as great as that of a wide, shallow one, and it may be that it is a matter of little consequence whether the space is obtained by increasing the width or the depth.

In a paper read by the late Sir Frederick Siemens before the Iron and Steel Institute, in 1884, and from which we have already made extensive quotations,* that distinguished author said:

> It can be easily shown that when flame is brought into contact with any solid body, it is more or less quenched, according to the substance, size and temperature of the body. A very simple experiment in proof of this, and one which is familiar to most people, is the following: Take any ordinary illuminating-gas flame, such, for instance, as a bat's wing, and place a glass rod or tube into the middle of it; the flame will immediately burn dull, and a large quantity of lamp-black will be deposited

* See JOURNAL of June, 1887, page 244.

on the piece of glass. This action is most marked when the rod is cold, but takes place, though in a less degree, at any temperature, for the reason that the material to be heated is necessarily always at a lower temperature than the flame, also owing to the disturbance in the combustion caused by contact of the solid substance with the flame. . . . . . The experiments I have made establish the following most important fact—namely, that a good flame, or, in other words, perfect combustion, can only take place in an open space or in one of sufficiently large size to allow the gases to burn out of contact with solid material.

In explanation of this fact the Author explained that he thought the electrical theory of combustion had the best chance of being the right one. According to it a flame consisted of explosions of lightning very numerous and minute. In accepting this theory it was at once evident why a solid body brought into such a flame would obstruct its action, such solid body having the effect of arresting the motion of the gas by attraction and adhesion.

The writer of the paper which has been quoted from applied these principles to boiler and other furnaces, and effected a saving of as much as 25 per cent. in the fuel consumed.

Now, so far as the contact of the flame with the sides and top of a fire-box is concerned, it will make little difference whether the fire-box is deep and narrow or wide and shallow. Obviously to keep the flame as much as possible out of contact with the sides, ends or top until combustion is complete, the fire-box should be of equal width, length and height. No locomotive fire-boxes are now in use which are both wide and deep—that is, we know of none which are, say, 6 ft. wide, 6 ft. high, and 6 ft. or more long. It may very well be—and Mr. Siemens' experiments sustain such an hypothesis—that if a form of construction for locomotives was practicable which would permit of the use of fire-boxes of proportions such as have been suggested, a higher degree of economy would be attained than is possible with any of the fire-boxes which are now used.

While existing forms of construction impose limitations on either the width or the depth of fire-boxes, there is no practical limitation to the size of the grates when they are placed above the wheels. Notwithstanding this fact, there is very great diversity in the size of the open grates, which are used for burning bituminous coal in the large fire-boxes, of which there are now many examples. As long ago as when D. K. Clark wrote his treatise on Railway Machinery he formulated the principle that the larger the heating surface in a boiler and the smaller the open grate area—provided enough coal could be burned in it—the greater would be the economy of fuel.

As has been pointed out for the application of Sir Frederick Siemens' theory, we must have plenty of width, height and length, and D. K. Clark's principle requires that we should have a small open grate. In the wide fire-boxes which are now used there is plenty of width and length, but what seems to be insufficient depth. In many cases, too, the grates are inordinately large, so that they are worked quite contrary to Clark's principle. The fact should be emphasized that a large fire-box does not necessarily mean a correspondingly large grate. We can have a very large amount of cubical space above the grate, while the open portion of the latter may be contracted by means of dead-plates and other appliances. In fact, the available open grate area is quite under the control of a fireman. By simply piling a thick layer of coal on one part and leaving another part open, he can regulate the supply of air which will pass through the bars, and thus practically increase or diminish the effective area. It therefore seems quite possible that the amount of open grate area is not a matter of much practical importance, provided the fireman understands his duties ; but it must be frankly admitted that we are in a very great state of ignorance of the whole subject, and that we do not know what are the most economical forms or proportions of fire-boxes or grates for burning bituminous coal.

NAVAL PROGRESS OF THE UNITED STATES.

THE report of the Secretary of the Navy for 1888 is an exceedingly creditable one. As Mr. Whitney well presents the facts, in March, 1885, the United States had no vessel of war which could have kept the seas for one week as against any first-rate naval power, and was dependent upon English manufacturers for the forging of guns, for armor and for secondary batteries.

The efforts of the Department were in the first instance devoted to the problem of domesticating in this country the industries for the making of armor and forgings for high-powered guns, and the first step in this direction was to discontinue all purchases of armor and gun-steel abroad. The wants of the Department in this direction were allowed to accumulate until contracts could be offered to the competition of domestic manufacturers. This was deemed an experiment at the time, and was accompanied by great individual effort toward enlisting the steel manufacturers in the undertaking, but it resulted successfully, and in June, 1887, contracts were entered into with the Bethlehem Iron Company under which the United States was guaranteed that within a reasonable time this country would have within its borders a plant equal to and probably the superior of any in the world for the production of armor and the forgings for high-powered guns. This plant is now nearly ready for work.

The efforts of the Department in ship construction have been devoted to the building of unarmored vessels for cruising, and the Department is able to report that when the ships in course of construction will have been completed the United States will take fair rank among the nations in the possession of unarmored cruisers.

We cannot at present protect our coast, but we can return blow for blow, for we shall soon be in condition to launch a fleet of large and fast cruisers. Two armored fighting ships of high class have been begun, and progress has been made in providing vessels specially adapted for coast defense, in which the new dynamite gun promises to be a valuable auxiliary.

It is gratifying to be able to report that notwithstanding the large expenditures for the new Navy in the last three years, the reduction in other directions has made the total expenditures of the Department less for these years than for the three years ending with 1884, the ordinary expenses having been reduced over 20 per cent.

In ordnance, as well as in ships, excellent progress has been made, and the Chief of that Bureau reports that 37 of the new high-powered steel guns, ranging from 6 in. to 10 in. in caliber, are practically finished, while 22 others are building, and the forgings for the 12-in. guns will be ready early in the present year. The plant of the Naval Gun Factory at Washington is making satisfactory progress, and will soon be in condition to begin work. The trials of the new guns so far completed have been very satisfac-

tory. Contracts for the smaller guns—the Hotchkiss and other rapid-fire guns—are also being filled.

It may here be noted that the first of the experimental cast-steel guns, about which there has been so much discussion, has not proved successful, the first 6-in. gun of this class, made in Pittsburgh, having failed in the first trial at Annapolis, bursting with a charge of 48 lbs. of powder. The result of this test, although unfavorable, can hardly be regarded as finally settling the question of cast-steel guns, and the trial of the Chester cannon will be looked for with interest. A careful examination into the cause of the failure of the first gun, which is now in progress, may give a satisfactory explanation of this result; but however this examination and the tests of the other gun may result, it will be an advantage to have the question decided.

One of the results noted by the Secretary is that substantial progress has been made toward the substitution of machinery of the latest and most improved types for the old-fashioned engines, which were in use in the Navy but a short time ago. How great the progress is may be shown by the statement in the report that the prevailing type of engine in use four years ago furnished 2½ H.P. per ton of machinery, whereas the triple-expansion engines for the latest cruisers can be worked up to 10 H.P. per ton of machinery. How great the gain is in economy and in space can be appreciated by those who have served on shipboard, and especially on a war-ship, where every foot of space is needed.

Of course there is very much still to be done before our Navy is on a proper footing, but that a beginning has been made, and in the right direction, is by itself alone a gratifying advance.

NEW PUBLICATIONS.

DIE REISE S. M. SCHIFFES "FRUNDSBERG" IM ROTHEN MEERE UND AN DEN KÜSTEN VON VORDERINDIEN UND CEYLON, IN DEN JAHREN 1885–86: BY CAPTAIN JEROLIM VON BENKO. Pola, Austria; issued under the Authority of the Ministry of War.

This is an account of a long eastern cruise made by the Austrian war-ship *Frundsberg* through the Suez Canal, the Red Sea, and the Indian Ocean, prepared from the Journal of the Captain, and issued under the authority of the Ministry of War. It gives an interesting account of the various ports visited, etc., and the conduct of the ship. It is accompanied by a large map, showing the route followed through the entire cruise, and by nine smaller maps, of different ports and localities.

MINERAL RESOURCES OF THE UNITED STATES FOR THE CALENDAR YEAR 1887; DAVID T. DAY, CHIEF OF THE DIVISION OF MINING STATISTICS AND TECHNOLOGY. DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY, J. W. POWELL, DIRECTOR. Washington; Government Printing Office.

This volume is the fifth of the valuable series on the same subject, which began in 1882, and extends the information contained in the previous volumes to include the calendar year 1887. It contains a great mass of statistics and other information arranged by classes and by States. The work of collecting these statistics and arranging them has been mainly done by the Bureau, under the direction of Professor Day, but this work has been supplemented by papers on various subjects, contributed by experts on the several topics. The paper on the Iron and Steel industry of the United States, for instance, has been written by Mr. James M. Swank, General Manager of the American Iron & Steel Association; that on Copper by C. Kirchhoff, Jr.; that on Coal by Mr. Charles A. Ashburner, and on Petroleum and Natural Gas by Mr. James D. Weeks.

The total estimated value of the mineral products of the United States for the year was in round numbers $542,000,000; metallic products forming about $250,000,000, and other mineral substances $292,000,000. Of the metallic products the most important was iron (including steel), estimated at $122,000,000; silver, about $53,500,000, holding the second place, and gold the third, the production being $33,000,000. Of non-metallic products, the most important, both in quality and value, was coal, which was estimated at $182,500,000; building stone, lime, petroleum, and natural gas following at long intervals. The year 1887 shows a considerable increase in mineral products, even over the prosperous year 1886, and their value is greater than in any previous year in the history of the country.

This volume is more complete than any of its predecessors, as the Bureau has increased the efficiency of its methods for the collection of statistics with experience, and is now served by a large number of assistants and observers at different points. It contains much information that is of value to any one interested in the subject, and is almost indispensable for many purposes.

MODERN HELIOGRAPHIC PROCESSES. A MANUAL OF INSTRUCTION IN THE ART OF REPRODUCING DRAWINGS, ENGRAVINGS, MANUSCRIPT, ETC., BY THE ACTION OF LIGHT, FOR THE USE OF ENGINEERS, ARCHITECTS, DRAFTSMEN, ARTISTS AND SCIENTISTS: BY ERNST LIETZE, M.E. New York; published by the Van Nostrand Company (price, $3).

This book, which is, as the Author says, not intended for professional photographers, but for engineers and draftsmen, is one which has been very much needed. The art of making blue-prints and other heliographic reproductions has grown up within a few years, and by its many advantages—including its superior cheapness and quickness—has almost entirely driven out of use the old, slow method of reproducing drawings by tracings. Most draftsmen know something about the common blue-print, but there are many other and finer processes which are not well known, and which present many advantages in special cases, and it has been almost impossible to find any account of these. Most of what has been written on the subject heretofore has been scattered through the various engineering periodicals, proceedings of societies, etc., and has been, therefore, difficult of access. A book in which the various processes are intelligibly and properly described, their methods analyzed, and their advantages shown, ought to be welcome to the great army of draftsmen, in which we would include all engineers, architects, and others who have occasion to make drawings. It appears to be a complete treatise on the subject, at least in so far that it includes all the different processes which have been put to practical use, including some which ought to be more widely known and used than they have been. It includes also a carefully prepared table of the chemicals used in the formulæ given, with their respective prop-

erties and some cautions as to the best method of handling them. This will be very serviceable, as draftsmen are not usually scientific chemists.

The book is an excellent piece of work, mechanically speaking, being well printed. There are a number of illustrations, and it is also accompanied by 10 specimen heliograms taken by different processes, including silver-prints, blue-prints, prussiate of potash prints, cyanotypes, carbon-and-ink prints, and uranium prints developed in different styles.

ABOUT BOOKS AND PERIODICALS.

AMONG the articles in the JOURNAL OF THE MILITARY SERVICE INSTITUTION for December is one on Military and Naval Manœuvres, by Major William R. Livermore; Compulsory Education in the Army, by Brevet Major-General James B. Fry, and Extracts from Minutes of the U. S. Military Philosophical Society, 1808—the latter giving some interesting historical notes on our earliest military association.

An article of much interest appears in SCRIBNER'S MAGAZINE for January, entitled "Railway Management," by General E. P. Alexander, who has had a wide experience as railroad manager in the South and Southwest, and can write from personal experience. This article contains an interesting account of the mystery of making time-tables, and of many other details of management, and gives an analysis of the organization of a railroad, which is complete in its arrangement. This article is one of the most complete of the SCRIBNER'S Railroad Series in its treatment of this very complex subject, giving probably as good an idea of it as could be done in so short a space as could be afforded it in the limits of a magazine.

A professedly humorous paper is a new departure in railroad journalism, but the GENERAL MANAGER, published in Chicago, has undertaken to fill the vacancy, and starts out with fair prospects of success. It is well printed, and gives in each number three colored cartoons and a variety of smaller cuts and entertaining matter.

The POPULAR SCIENCE MONTHLY for January contains an illustrated article on the Guiding Needle on an Iron Ship, by Lieutenant-Commander T. A. Lyons, describing the means taken to counteract the disturbing influences of masses of iron on the compass on board of iron vessels. The always important subject of House Drainage is discussed in the same number by Dr. John S. Billings, U. S. A., who is a high authority on the subject. Dr. Billings's article follows one on the same subject which was published in the July number of the same magazine, and which then called out much criticism and discussion.

The last number of the PROCEEDINGS OF THE UNITED STATES NAVAL INSTITUTE contains articles on the Necessity and Objects of a Naval War College, by Captain A. T. Mahan; Steel Inspection of Structural and Boiler Material, by Lieutenant-Commander J. G. Eaton; the Tactics of the Gun as Discoverable from Type War Ships, by Lieutenant J. F. Meigs; Naval Administration, by Rear-Admiral Luce; Notes on the Literature of Explosives, by Professor Charles E. Monroe; a Study on Fighting Ships, from the French, and the usual notes on naval matters of interest.

From December 1 the publishing business of the late D. Van Nostrand will be continued by the D. Van Nostrand Company, of which Edward N. Crane is President and William H. Farrington Secretary and Treasurer. The new organization will continue the business of publishing and dealing in scientific books at 23 Murray Street, without change, Mr. Farrington having been long connected with the old firm.

BOOKS RECEIVED.

TRANSACTIONS OF THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND: THIRTY-SECOND SESSION, 1888-89. Glasgow, Scotland; issued by the Institution.

MITTHEILUNGEN AUS DEN GEBIETE DES SEEWESENS: VOLUME XVI, 1888, Nos. I-IX. Pola, Austria; issued by the Imperial Hydrographic Office.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; issued by the Institution. The present issue consists of a paper on the Use and Testing of Open-Hearth Steel for Boiler Making, by the late Hamilton Goodall, with an abstract of the discussion on the paper.

SOME RECOLLECTIONS OF AN OLD PHOTOGRAPHIC CLUB: BY COLEMAN SELLERS, E. D. Reprinted from *Anthony's Photographic Bulletin*.

PREPARING FOR INDICATION: PRACTICAL HINTS, THE RESULT OF TWENTY-THREE YEARS' EXPERIENCE WITH THE STEAM-ENGINE INDICATOR: BY ROBERT GRIMSHAW, M.E. New York; the Practical Publishing Company, 21 Park Row (price, $1).

SECOND ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION: THOMAS M. COOLEY, WILLIAM R. MORRISON, AUGUSTUS SCHOONMAKER, ALDACE F. WALKER, WALTER L. BRAGG, COMMISSIONERS; EDWARD A. MOSELEY, SECRETARY. Washington; Government Printing Office.

REPORT OF THE THIRD ASSISTANT POSTMASTER-GENERAL FOR THE FISCAL YEAR ENDING JUNE 30, 1888. H. R. HARRIS, THIRD ASSISTANT POSTMASTER-GENERAL. Washington; Government Printing Office.

TREASURY DEPARTMENT: ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STATISTICS ON THE FOREIGN COMMERCE OF THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1888. Washington; Government Printing Office.

REPORTS FROM THE CONSULS OF THE UNITED STATES TO THE STATE DEPARTMENT. No. 95, JULY, 1888; No. 96, AUGUST, 1888. Washington; Government Printing Office.

THE CORNELL UNIVERSITY REGISTER, 1888-89. Ithaca, N. Y.; published by the University.

NOTES ON THE DIFFERENTIAL BRAKE: WRITTEN FOR F. M. DAVIS BY HENRY A. VEZIN, M.E. Denver, Col.; *News* Printing Company.

THE DOW POSITIVE PISTON PUMP: CATALOGUE. Philadelphia; the Kensington Engine Works, Limited, Francis Brothers.

THE VOGELSANG SCREW PROPELLER AND ITS ADVANTAGES OVER ALL KNOWN METHODS OF MARINE PROPULSION: BY ALEXANDER VOGELSANG. Brooklyn, N. Y.; issued by the Vogelsang Screw Propeller Company.

THE KENSINGTON FEED-WATER HEATERS AND PURIFIERS: CATALOGUE. Philadelphia; the Kensington Engine Works, Limited, Francis Brothers.

CATALOGUE OF THE LIBRARY OF THE BROWN & SHARPE MANUFACTURING COMPANY: 1888. Providence, R. I.; printed for the Company.

SCIENTIFIC AND MECHANICAL BOOKS; CATALOGUE. New York; Theodore Audel & Company, 91 Liberty Street.

THE DEVELOPMENT OF THE MILITARY RIFLE.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

Among the many and wonderful improvements in military arms and material during the last half century, that of the rifle has perhaps been the greatest. In the typical modern weapon, with a caliber about that of a squirrel rifle, and of but little greater weight, it is hard to recognize a lineal descendant of the clumsy arm with which the Spaniard of three centuries ago built up an empire at home and conquered one abroad.

If the soldiers who followed the flag and fought the battles of a hundred years ago with a twelve-pound musket of enormous caliber, could come back and see the weapon we put into the hands of our modern infantryman, and knowing nothing of its capabilities, he would have for it probably the same contempt that the Philistine giant had for the sling and stones of the Israelite champion.

Like most other things, the modern rifle has grown from small beginnings. The first portable fire-arm was, however, in the matter of size alone, a most formidable weapon—from 4 to 8 ft. in length and weighing from 15 to 50 pounds. To fire it required the services of two men—one to support it upon its muzzle-rest, and the other to touch it off—the vent being on top of the barrel. The difficulty of keeping the priming in place led to the first improvement—that of putting the vent on the side with a pan to hold the priming. By the addition of a curved arm, pivoted on the side of the stock, and carrying a bit of slow-match, we have the full-fledged matchlock (1517), which held the field as the principal portable fire-arm for fully a hundred years. It was the first serviceable weapon of this kind that had appeared, but remembering its weight and clumsiness, one cannot wonder that when it came to fighting at close quarters the soldier of that day was very prone to fling away his fire-arm and resort to the more familiar pike and sword. The wheel-lock appeared about the same time, in which the arm with its lighted match gave place to a toothed wheel, which, revolving and impinging against a composition of iron and antimony, produced the sparks for igniting the priming. But this system was complicated and expensive, and was never generally adopted, its use being confined to pistols and short arms for mounted men.

About 1525 the Spaniards reduced the length of barrel of their matchlock, and its weight to about 15 pounds, greatly increasing its efficiency. From them it received its distinctive name, *mousquet.*

In 1630 the flint-lock was introduced, and as thus improved, and with the addition of granulated powder, the weapon of the infantryman remained essentially the same for 200 years ; the further improvements being in the substitution of iron for wooden ramrods and the use of rude cartridges.

The English "Brown Bess" musket, which figured in our early French and Indian wars, in the Revolution, and in the Napoleonic wars, weighed 11¼ pounds, and had a ¾-in. bore. The French musket of the same date weighed two pounds less. The "Brown Bess" held the field until 1839, when it gave place to a lighter weapon with a percussion lock.

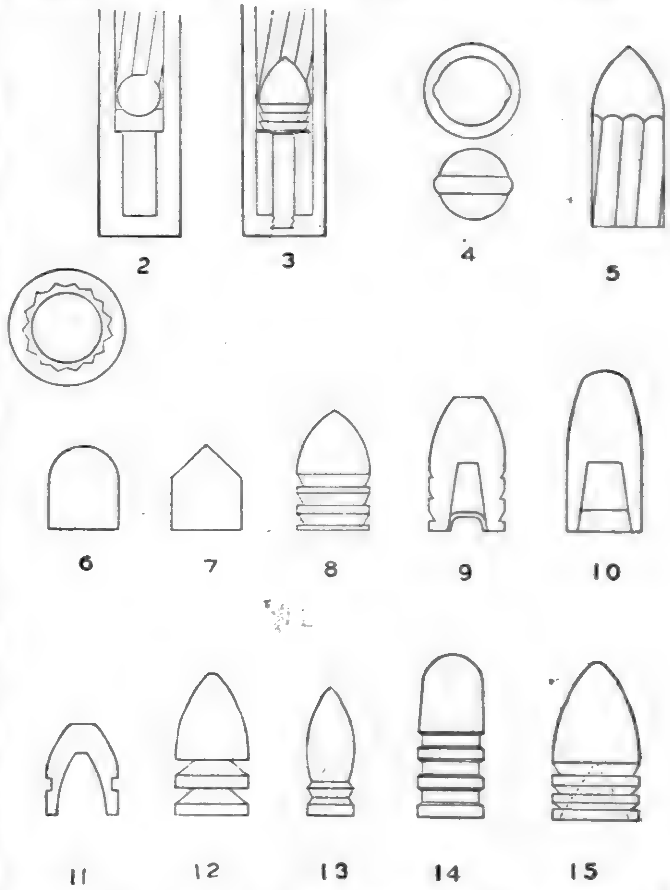
About the time of the introduction of the percussion musket the question of adopting the rifle as the military weapon began to be agitated by all the great military powers. The advantages of the rifle over the smooth-bore had been recognized. The value in both range and accuracy of giving a projectile a rotary motion was fully appreciated, and rifles in moderate numbers had long been in use. But the mechanical difficulties in the way of imparting this motion to projectiles, and the slowness with which all the rifles of the day were loaded, seemed insuperable obstacles to the adoption of the rifle as a military weapon in the hands of all soldiers, and its use was for some time confined to small, picked bodies of men, leaving the mass of the troops still armed with the smooth-bore musket.

The accompanying cuts will give a general idea of the development of the rifle, with special reference to the form and size of its projectile, and the methods employed for giving it rotation.*

In the first rifle the grooves were numerous and like the teeth of a saw (fig. 1). By using a heavy ramrod, with a mallet, the lead was driven into and made to take the grooves. With this piece loading was a slow process, cleaning was difficult, and the sharp points of the grooves soon became disfigured.

The next system adopted was that of a French infantry officer, Delvigne (fig. 2). In this the powder was contained in a cylindrical chamber considerably smaller than the bore. The bullet, smaller than the bore, was attached to a wooden sabot, which, when dropped into the bore, rested on the shoulders of the chamber. A heavy ramrod with a concave head served to force the projectile into the grooves. The sabot prevented the bullet from entering the chamber and preserved the powder grains intact.

In the *carabine à tige,* invented by Colonel Thouvenin, likewise a French officer, the chamber of the Delvigne



system was replaced by a small spindle or pin, screwed into the breech-screw (fig. 3). The length of the spindle was such as to give room for the powder charge around it, while upon its point rested the bullet. As in the preceding systems, the bullet was forced into the grooves by blows of the ramrod. In this system the elongated bullet was used, and seems to have been the first military rifle using an elongated projectile. In the early attempts to use this form of bullet the first shape given was the cylindro-spherical, next the cylindro-conical, and finally the ogee-shaped ball (figs. 6, 7, and 8).

In all the earlier systems of rifles, rotation of the bullet was secured by driving the lead into the grooves with the ramrod. This was objectionable since it disfigured the projectile and decreased both its range and accuracy. In the systems that followed efforts were made to secure rotation by other means. Two general methods were employed to this end. The first was by giving a peculiar and corresponding shape to both the bullet and the bore, and the second by forcing the projectile by the action of the powder. As examples of the first class we have the Brunswick rifle (fig. 4), in which a projection or girdle,

* In the first four cuts no attempt has been made to give the actual dimensions of the bullet ; the object being simply to represent the means used to produce rotation.

formed on the bullet, corresponded to the two spiral grooves of the bore. In the Whitworth system the bore is in the form of a twisted hexagonal prism, making one complete turn in about 20 inches. To prevent stripping, the lead was hardened by alloying it with tin and manganese (fig. 5).

To obtain rotation by the action of the powder alone, Colonel Minié constructed a bullet with a deep conical cavity, and inserted in this cavity, at the base, an iron cup or *culot*. The powder gases acting against this cup forced the lead outward into the grooves (fig. 9). In the English bullet (fig. 10) the iron cup was replaced by a conical plug of boxwood. This served the same purpose as the cup, and at the same time preserved the bullet from disfiguration in transportation. It was soon found that the direct action of the powder gases acting in the cavity of the bullet was alone quite sufficient to secure rotation, and thereafter both cup and wooden block were omitted. The United States service bullet in use at the time of the introduction of the breech-loader was of this pattern (fig. 15). The grooves cut upon the cylindrical portion of the bullet served the double purpose of holding the lubricant and of giving the projectile a better hold on the rifling of the bore. They were also supposed to increase its stability, serving the same purpose as the feathers upon an arrow.

The French troops of the line used a bullet considerably lighter than any of the others above described (fig. 11). It had a flatter trajectory than was usual, but was inferior in both accuracy and range.

The bullets used in the Austrian service of the same epoch were of the solid-expanding type. The explosion of the charge *upset* the projectile, crowding up the disks formed at its base (fig. 12). The Swiss rifle used a bullet of considerably smaller caliber and relatively longer than those of any other service. The forcing was by means of a cloth patch tied around the grooves on the bullet (fig. 13).

Nearly all the changes and improvements above referred to took place between the years 1840 and 1860. At the latter date the muzzle-loading rifle had been adopted as the weapon in the armies of all the great civilized powers. The calibers varied from about 0.41 in. of the Swiss rifle to about 0.60 in. of the Spanish. The Springfield muzzle-loader had a caliber of 0.58 in. The charge of powder employed varied over even wider limits. In the Russian Cossack rifle, of 0.55 in. caliber, the charge was but 31 grains, with a corresponding weight of bullet of 176 grains. The other extreme was the Swedish navy rifle, caliber 0.57 in., with a 77-grain charge and 401-grain bullet. In length the bullets ranged from 1.39 calibers of the Cossack to 2.44 calibers of the Swiss rifle. In the matter of twist the first rifles had one turn in 20 feet. This was gradually reduced, until at the date of which we speak, 1860, it varied from 4 to 6 feet.

BREECH-LOADING RIFLES.

With the introduction of breech-loading arms an entire change in the method of forcing the projectile took place. In all breech-loading systems the diameter of the bullet is slightly larger than the diameter of the bore across the lands of the rifling, and it is slugged or compressed into the grooves on passing from the chamber into the bore of the piece.

The first breech-loader regularly adopted as a military weapon was the Prussian needle-gun, which antedated, in this respect, any other system by a quarter of a century. In 1840, when the other European powers were considering the advisability of discarding the smooth-bore for a rifle, the Prussians at once jumped over the intervening system of a muzzle-loading rifle and adopted the needle-gun breech-loader, which appeared in 1841. It made its first appearance on the battle-field in the campaign against the Danes in 1850. Its superiority over existing systems in rapidity and accuracy of fire was pronounced, but the prejudice against breech-loading arms in general was so strong that the lesson it taught was entirely overlooked. Even as late as 1863 a recognized authority on military subjects in this country, in writing of the wasteful expenditure of ammunition on the battle-field, says: "It becomes a self-evident fact that they (soldiers) fire too fast already, and that it is only adding to the evil to give them the means of firing four or five times as fast by placing breech-loading guns in their hands." The Prussians, however, held manfully to their new weapon, despite its very apparent defects. In 1864 it again justified their faith in the war with Denmark, and two years later in the war with Austria, when pitted against the muzzle-loading rifle of that power, it won so complete a victory that in that campaign it may be said to have annihilated all opposition. It was still, however, a very defective weapon. Using a paper cartridge-case, there was no obturation, and the escape of gas at the breech was great; the fulminate was at the front end of the cartridge, and to reach it the long needle had to traverse the entire length of the cartridge; it was liable to rust, and breakage was of frequent occurrence. In ballistic qualities it was inferior to many of the muzzle-loading systems, but in rapidity of fire it was far ahead of any of its rivals.

Between 1860 and 1870 M. Chassepot developed his rifle, and at the latter date we find it in the hands of the mass of the French army. The Franco-German war that followed was signalized as the first meeting of breech-loader against breech-loader in the hands of two great armies. In ballistic qualities—range and accuracy—and in certainty of manipulation the Chassepot was the better arm. But it was a contest where breech-loader, allied to the tactics of the muzzle-loading arm, was pitted against breech-loader joined to breech-loader tactics. The signal triumph of the latter is well known.

The caliber of the needle-gun was 0.61 in., with a 66-grain charge and a 451-grain bullet. The Chassepot had a caliber of 0.43 in., with a corresponding weight of powder and ball of 87 and 385 grains.

In England the muzzle-loading Enfield was converted into a breech-loader of the Snider pattern, still retaining the old caliber of .577, with a breech-lock opening to the right. This arm was replaced, five years later, by the Martini-Henry—a Henry barrel with a Martini breech-action—almost identical with the American Peabody.

In Germany, after the war of 1870–71, the needle-gun was discarded for the Mauser. France replaced her Chassepot with the Gras. Austria converted her muzzle-loaders into breech-loaders of the Wanzl pattern, and later adopted the Werndl system of breech-loaders. Russia converted her Cossack rifle into the Kruka breech-loader, and afterward adopted the American Berdan. Spain adopted the American Remington, and Italy the Vetterli.

In the United States the Springfield muzzle-loader was converted into a breech-loader (1870). The barrel was re-bored, a tube inserted, reducing its caliber from 0.577 in. to 0.50 in., its length reduced by 4 in. A section of the rear end of the barrel was cut out and a breech-block inserted. This was followed by what is known as the "Springfield Rifle, Model 1873." In it the barrel was made of low steel instead of iron, and the caliber still further reduced to 0.45 in. There have been several changes of model since that of 1873, but they have been in minor parts of the arm, in the sights, etc. Essentially the arm is the same as that adopted fifteen years ago. The present service bullet is represented in fig. 14.

In nearly all of the systems here mentioned we find a reduction of caliber to about 0.43 in., and a relatively increased length of bullet from about 1.5 to about 2.5 calibers. The number of grooves in the rifling varies from three in the Springfield to seven in the Martini-Henry, with a twist of one turn in from 22 to 25 in.

With regard to the breech-loading mechanism and firing arrangement, we find the bolt system almost universal. In it the opening and closing of the breech is effected by a bolt moving in a direct horizontal line with the bore, and carrying a firing-pin with the necessary spring mechanism for firing the piece. The principal exceptions to the bolt system we find in the Martini-Henry and the Werder (Bavarian), in which there is a falling hinged breech-block with spiral or flat spring and striker; the Snider and Springfield, with a turn-over block, side lock, and striker; the Remington, with a segmental, direct block, with flat spring and striker.

These arms were sighted for ranges varying all the way from 670 yards in the Russian converted Kruka, to 2,000 yards in the French Gras—1,200 yards being about a mean.

(TO BE CONTINUED.)

THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

(*Continued from page* 543.)

CHAPTER XLI.

NOTES AND RECORD BOOKS.

The manner of preserving all these notes in book form varies very much according to the ideas of the different engineers and the fulness that is required.

Plate LXVI is a sample page of a large cross-section book for office use which contains all the data that have been used in the calculation.

Col. 1. Numbers of stations.
" 2. Side height and distance to left.
" 3. Center cut or fill.
" 4. Side height and distance to right.
" 5. Sum of side distances.
" 6. } Values of m taken from Diagram for prisms
" 7. } 50 ft. long.
" 8. } Sum of adjacent readings taken from Dia-
" 9. } grams making prisms 100 ft. long.
" 10. Prismoidal correction.
" 11. } Actual amount of material per station.
" 12. }

For the use of the Resident Engineer on Construction only the data in columns *marked* 1, 2, 3, 4, 5, 6 is required in the field; that is, the full cross-section notes with the number of cubic yards of cut or fill at each station. If it is desired to use the Diagram of Triangular Prisms for estimating quantities upon railroad work, the center height C must be increased by the altitude of the *grade triangle*, or the triangle formed by continuing the sides of the cut or fill below or above the road-bed until they meet, thus forming a triangle the base of which is the width of the road-bed w, and the altitude $\frac{w}{2n}$, n being the ratio of slope of the side. We use therefore for the altitude of the triangular prism $C + \frac{w}{2n}$, and from the volume thus obtained subtract the volume of the grade prism, and the remainder is the volume of the required prism. As the volume and altitude of the grade prism are constant with the same width of road-bed and same ratio of slope, a table should be calculated giving the altitude $\left(\frac{w}{2n}\right)$ and the volume of the prism (taking the length as 100 ft.) for the different widths of road-beds and ratio of slopes that will be used.

It is not necessary to subtract the volume of the grade prism from the volume obtained for each station, but from the total volume obtained from any one cut or fill, subtract the volume of the grade prism for one station as given in the table multiplied by the length of the cut or fill in stations. For very rough preliminary work where much must be sacrificed to time, and the country is passably level, the quantities can be very rapidly estimated by using the center heights only and a table calculated for level sections.

PLATE LXVI

Sta	$\frac{d}{h}$	C	$\frac{d'}{h'}$	D	Cuts from Diagram	Fills from Diagram	Cuts per Sta.	Fills per Sta	Prismoidal Correction	Actual Cuts per Sta.	Actual Fills per Sta.
1	2	3	4							5	6

With regard to preliminary estimates of the cubic contents and cost of the various masonry structures, diagrams can be made from which all the required information can be taken at sight. In making a diagram for an arched culvert, for instance, it can be assumed in the Preliminary Estimates that all arched culverts of the same width of opening and same class of masonry will have the same section—that is, the same number of cubic yards per foot of length, exclusive of wing walls and parapet walls. The wings and parapets will contain the same amount of masonry for the same width of opening without any regard to the actual length of the culvert. The number of cubic yards of masonry in any culvert of a given cross-section (exclusive of wings and parapet walls) will vary directly as the length, and this length is always the distance between the slope stakes minus two times a constant, the value of this constant depending upon the height of the parapet wall. Thus in Plate LXVII CC = the distance between the slope stakes, PP the parapet walls of the culvert BB. Then the length of this culvert would be $CC - 2a$.

$$2a = 2Pn.$$

In preliminary estimates where only the center height is used, the section can be taken as level, and the length of the culvert would be:

$$w + 2cn - 2a.$$

w = width of road-bed.
c = center fill.
n = ratio of slope.
a = constant depending on height of parapet wall.
n should never be less than $1\frac{1}{2}$, and in some material 2.

Then the equation for the cubic contents of any arched culvert of a given section:

$$m = ls + b.$$
$$m = (w + 2cn - 2a)s + b.$$

s = cubic yards in section one foot long and includes foundation.

b = cubic yards in wing walls and parapet walls.

The diagram should be so constructed that the different

values of C along the bottom are represented by the vertical lines.

The values of m, either in cubic yards or in the cost, will be written upon the vertical lines and represented by the horizontal lines.

Each culvert of a different cross-section will be represented by a curved line drawn diagonally across the dia-

gram. As a sufficient number of points of the curved lines representing the different culverts have to be calculated under some circumstances, it is fully as easy to tabulate the results as it is to construct a diagram, and for any ordinary work the tables needed would not be so cumbersome as to in any way impair their usefulness.

In the same manner can be calculated and constructed diagrams that shall give upon inspection the approximate weight and cost of every iron bridge, the number of feet of lumber in every wooden structure of standard type, and the amount of masonry in and cost of all open culverts, abutments, and bridge piers. By having such diagrams as these made once for all, the work of making a preliminary estimate is reduced to a minimum both as to time and expense, and a maximum of accuracy is secured.

CHAPTER XLII.

FINAL LOCATION.

The object of a FINAL LOCATION of a railroad line is to mark out exactly upon the ground the center line of the road as it is to be constructed.

From a careful examination of the plans of the preliminary lines with the contours and topographical details, the best line between the termini as to general direction can be at once decided upon and located upon paper. The alignment notes of the paper location are copied into a note-book in such a manner as to be perfectly understood by any transitman. The notes show the length and direction of every tangent, the location of the P C, P C C, P S, etc., the length and direction of every curve, together with the degree of curvature. This note-book is then sent into the field and the line re-run in accordance with the notes.

It will always be found necessary to fit the smaller details of the line to the ground in the field. That is, if a curve having a certain position, radius, and length in the paper location does not fit the ground when run in in the field as well as was expected, or if there appears any possibility of improving the line, the paper location must be abandoned at once and the best line on the ground found by repeated trials.

The line shifted to one side or the other, the relative extent of curves and tangents changed until beyond a reasonable doubt, the best line has been obtained. In this final location all the curves are run in and offsets made for the transition curves. These transition curves need not be run in until the position of the center line is definitely determined.

In making slight changes in the position of the line in final location there will be seen the great advantages to be obtained by the use of that system of transition curves that has been described over any other system that renders the line rigid and inflexible, and does away with the possibility of moving or changing one part of it without changing much that precedes and follows.

After the final line has been definitely established, levels should be run over it and carefully checked. From the levels a profile should be made, and upon this the grade-line should be established. As has been stated, this is one of the most delicate and critical operations connected with Railroad Location, and the full bearing of every question in the problem should be fully studied.

After the grade has been established the center heights at each station should be calculated. That is, the difference on the center line between what is to be the elevation of the finished grade and the actual elevation of the ground.

From data taken in the field, the angle of slope to be given the sides of every cut and fill can be decided at once, and then the slope stakes should be put in.

CHAPTER XLIII.

FINAL ESTIMATES.

When this has been done careful and elaborate estimates are to be made, and everything put in final condition for the work of construction to commence. This estimate must include the amount of each class of material to be moved, with any data possible relative to the approximate average haul, or the average distance the material must be moved.

In classification of earth-work the material is divided into three classes :

1. Earth.
2. Hard Pan or Loose Rock.
3. Solid Rock.

There is no sharply drawn line separating the one from the other. The limits of each will vary somewhat upon different roads, but the following definitions will give some general idea as to what is meant.

1. *Earth:* All material to be excavated that is not included under the heads of Hard Pan or Loose Rock or Solid Rock.

2. *Hard Pan or Loose Rock:* All boulders and detached masses of rock containing more than one cubic foot in bulk and less than four cubic yards ; all indurated clay, gravels, and shales that can be removed with picks (although the use of explosives may be the more economical).

3. *Solid Rock:* Includes all rock occurring in ledges that require drilling and splitting, and all detached masses of rock containing four cubic yards or more in bulk.

Before the work of construction has been done this classification, even under the best methods, can only be made in a general way. The object of it is simply to allow a fair estimate to be made of the probable cost of the work, and also in order that contractors may be able to make intelligent bids for the future work.

The ESTIMATE OF QUANTITIES should be made with much more care than was necessary in the preliminary estimates.

Where the surface of the ground is very uneven and the work in rock, or for any other reason liable to be very expensive, the cross-section at each station and at intermediate stations should be very carefully plotted, and the areas of the cross-sections taken exactly from the plot by means of the PLANIMETER. A full description of this little instrument can be found in the catalogues of some of the instrument dealers. In general terms, it is a mechanical integrator having two arms and a registering disk, with the other details so arranged that if one arm is fixed to the plan and the pointer on the other moved around the boundary line of any shaped figure, regular or irregular, the index will give the exact area of this figure, either in square inches or any required units according to the adjustment of the machine. When the final location has been made in all its details, slope stakes and all other necessary stakes put in, estimates and classifications made, with all needed plans and profile, the railroad passes out of the hands of the LOCATING ENGINEER into those of the ENGINEER IN CHARGE OF CONSTRUCTION, and everything is ready for the work of construction to commence as soon as specifications have been made out and contracts let.

CHAPTER XLIV.

PRESERVING RECORDS OF LOCATION.

There are two other points upon which we must touch before we close, and that is the records that should be kept by the railroad company of the work done on location, and of all the real estate owned by the company.

With regard to the preservation of the notes of the work done on location, it may be said that all of these notes should in the end be forwarded to the main office, together with the plans and profiles used in the field. There are very few of these plans and profiles but that at some time may be of inestimable value to the railroad company. All of these original notes should be most carefully preserved, not only in their original form, exactly as sent in from the field, but also by exact copies of them made in ink.

It will at once be seen that every effort should be made by the field engineers to make these notes as full and explicit as possible. Let every point that can in any way have a bearing upon questions that may arise in connection with the future road be most carefully noted. Give the dates upon which all the work was done, with the names of the rod men, instrument-men, and engineer in charge, and any circumstances connected with the doing of the work that can possibly ever be of any use.

Many of these points may seem very small and unimportant matters about which to take so much trouble, but no one can tell of what inestimable value they may prove to the road at some future time. At any rate, the amount of extra labor and possible extra cost (and this extra labor and care by no means necessitates any extra cost, but is dependent upon the habits of instrument-men with regard to taking notes) entailed by this noting of every possible point of future importance is very small, and if the time should ever come when one only of the minor points of information should be needed, the benefit to the road from having it recorded in a convenient and authentic manner would undoubtedly repay the railroad company many times for the extra cost and trouble of obtaining and preserving *all* of these minor points.

There should be at least two copies of all the original notes and tracings or blue-prints of all the plans. Since the general introduction and adoption of the blue-printing process, after one tracing has been made of any plan there is comparatively little work in multiplying these copies to any extent, and absolutely no excuse for not preserving a sufficient number of copies.

There should be at least two sets of very highly and elaborately finished plans, showing the center line of the road, all the switches and side tracks, stations, etc., the exact boundary lines of all the right of way or property owned by the company along the line of the road, with the boundary and division lines of all the adjacent properties and the names of the owners. These finished maps should show every opening in the road and the means by which it is to be passed, and as much topography or contour lining as possible. These plans should be made upon sheets of such a size as to permit of their being bound into book form. Either 24 in. or 18 in. wide by 36 in. long is a good size. The scale should be such as to allow about two miles to a sheet. The center line should run around the center of the sheet, with every change in the alignment clearly noted. There should be drawn the limits of the right of way and all line fences. Below this should be the profile, showing the natural surface of the ground, the grade line, and every opening in the track. On the grade line should be marked clearly the rate of grade and the elevation of every point where the rate of grade changes.

The remainder of the sheet should be filled up with detailed plans of any of the smaller stations that come in that portion of the line shown upon the sheet. These station plans should be on a much larger scale than the general plan of the road. Much of the work that must in the end go upon these finished maps cannot be done until the work of construction is finished.

CHAPTER XLV.

REAL ESTATE.

With regard to the REAL ESTATE that may be acquired by the company, it may be said that when any piece of property is deeded to the company the engineer should prepare a complete plan of it, and write out a full description, which should be inserted in the deed. Then this description should be copied into the *Real Estate Record Book*, together with the character and number, where recorded, and the date on which it was recorded; any particulars as to the manner of purchase, price paid, terms of payment, names of both parties to the transaction, date of purchase, and any other particulars in connection with the purchase that may be deemed necessary. There should be made two copies of this *Right of Way Book*, one to be kept in the fire-proof safe of the Treasurer of the railroad company, and the other copy in some secure fire-proof place not in the same building as the Treasurer's office. The plans, specifications, and bills of material of all the structures should be preserved with care, and in such a manner that they can be referred to when needed with no loss of time and without the necessity of overhauling the entire stock of plans that the company possesses before the required one can be found, as is too often the case on many of our otherwise well-managed and orderly railroads.

CHAPTER XLVI.

THE CONTRACT.

Before construction can commence on any part of the road it is not only necessary that complete and accurate plans and profiles should be made showing exactly the amount of work to be done and the result to be obtained, but these plans and profiles should be accompanied in every case by full and explicit specifications, stating the manner in which the work is to be carried on and finished, defining fully the material to be used in each case, and the degree of excellency to be attained—that is, while the plans and profiles show exactly *what* is to be done, the specifications show the *manner* in which it is to be done, and establish a standard below which none of the finished work can fall.

These are all followed by the CONTRACT, which is simply an agreement between the railroad company and the contractor as to the conditions under which the work is to be done, and the terms upon which payment is to be made.

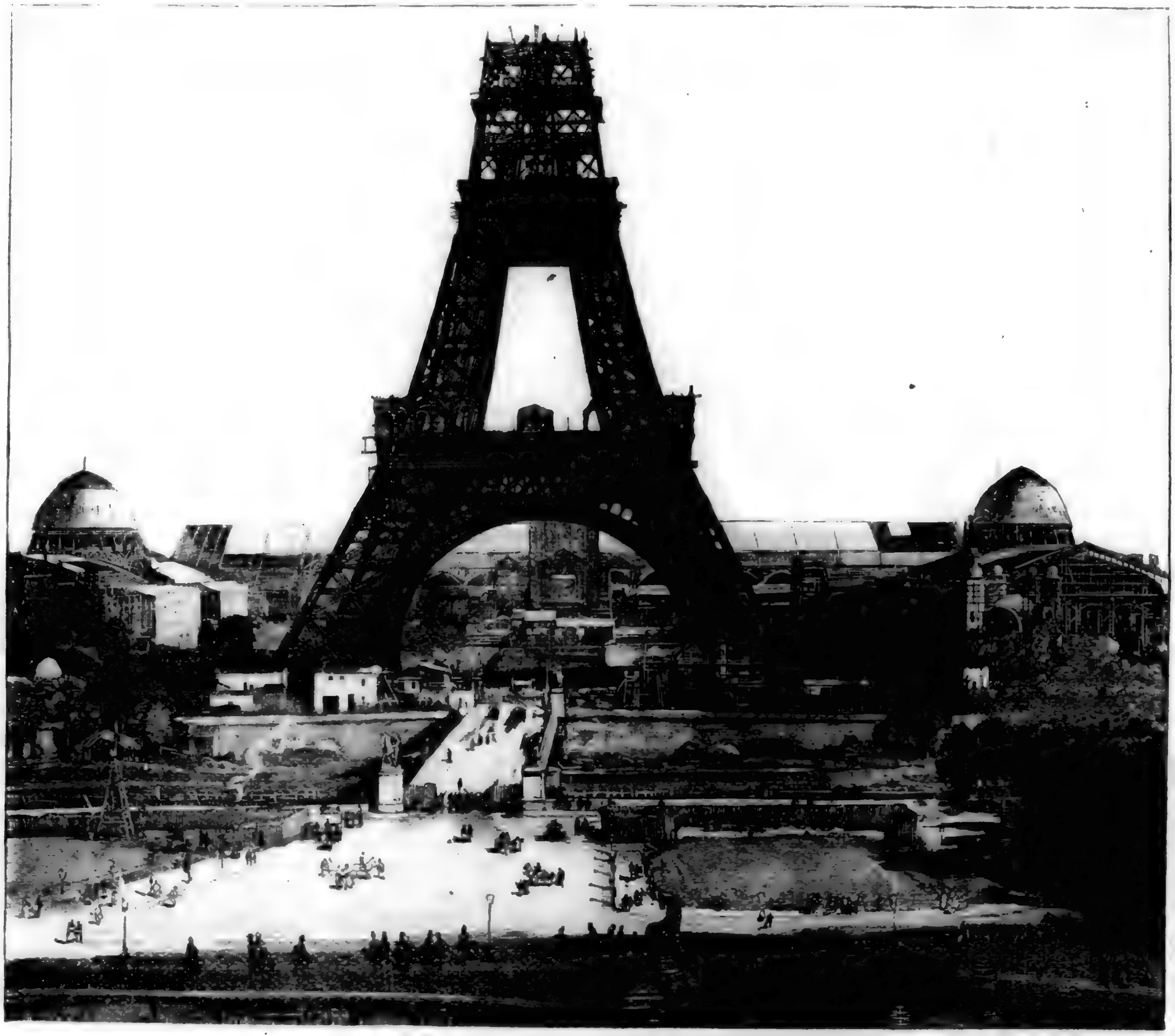
Railroad specifications and contracts, however, form too extensive a subject to be treated in a chapter, and do not, moreover, fall properly within the province of the Locating Engineer.

The writer trusts that those readers who have followed these articles during the past year and have studied the methods of Locating a Railroad, will not be indisposed to continue those studies and to consider some practical hints on the Construction of the Railroad and its auxiliary works.

THE EIFFEL TOWER IN PARIS.

(From *Industries.*)

On November 1 the great Eiffel Tower now under construction on the Paris Exposition grounds had attained a height of 178 meters (587 ft.), and the present rate of progress is at the rate of 36 ft. per week. If this be maintained, the whole of the principal parts of this immense structure will be erected by the end of January, 1889. Meanwhile the decorative and accessory parts of the work are not neglected, and there is every prospect that the tower will be completed in all its details at the opening of the Exhibition. We give in the accompanying illustration a view of the tower as it appeared when seen from the opposite side of the river at the beginning of November. The illustration also shows some of the principal buildings now in course of construction on the grounds of the Exhibition. The erection appearing like a tower in the background, within the center arch of the Eiffel Tower, is the lower portion of the large dome which rises above the main entrance to the Exhibition; the long building at the back is the large machinery hall, extending right across the Champ de Mars; the building on the right of the tower, with a cupola, is intended for the exhibition of liberal arts; and the corresponding building, on the left, for that of the fine arts. At the foot of the tower, and along the quay, there are now in course of erection various buildings, which will also form exhibits, the intention being to bring before the visitor a comprehensive collection of human dwellings, and in that way illustrate the development and history of domestic architecture.



THE EIFFEL TOWER AT THE PARIS EXPOSITION.

THE ABT RACK-RAIL SYSTEM.

In a recent number of the Journal (October, 1888, pp. 442–443) the rack-rail system for mountain railroads devised by Herr Roman Abt, the best system of the kind yet introduced, was illustrated and described. In an article recently published in the Vienna *Zeitschrift für Eisenbahnen und Dampfschiffahrt*, Herr Abt gives an elaborate argument in favor of his system, which lack of space prevents us from reproducing, and adds the following account of recent progress made:

A rack-rail road on the principles laid down by me, which has been in operation for a year, has given much satisfaction, and has, in view of the ascertained results, this summer received the first prize (7,500 marks) given by the Union of German Railroad Managements.

The first example of my system was built under the management of Herr A. Schneider, Director of the Brunswick Ducal Railroad, and is an extension of

the Halberstadt-Blankenberg line into the Harz Mountains.

The toothed rack or rack-rail is made in three parallel plates or bars 20 mm. thick and 110 mm. high. The distance between these bars, as in all the later lines, is 120 mm.; the length of each rail is 2.640 meters, and each rests on four cast-steel chairs fastened by lugs and keys to iron ties, while two bolts secure the rack-rail to each chair.

The locomotives have three pairs of coupled adhesion wheels, and under the foot-board a pair of bearing wheels, making a steady-running machine. The rack-rail machinery consists of two coupled axles carrying the toothed wheels, which are supported by an additional frame suspended from the two outside driving axles, and this frame can be removed for repairs without dismounting the adhesion axles. A pair of inside cylinders serves to drive these axles, and also, when the rack-rail is not in use on the level portions of the road, acts as an air-brake to regulate the speed.

The success of this first line led to the building of others. In 1885 Herr Oertel built a connecting line of standard gauge on the Abt system from the Harz Railroad at Lehesten station to his slate quarries at Oertelsbruck, and in his quarries he has also a system of narrow-gauge lines. On this main line the rack-rail consists of two bars, each 20 mm. thick and 110 mm. high, on iron ties, while on the narrow-gauge lines it is also of two bars 15 mm. thick and 110 mm. high, on wooden ties.

The locomotives for the standard-gauge line have two pairs of coupled adhesion wheels and one pair of driving wheels, the rack-rail axles, wheels, and cylinders being arranged as in the locomotives on the Harz Railroad, above described. The small narrow-gauge locomotives have two pairs of adhesion wheels and one toothed wheel, the three axles being coupled and worked by the same cylinders.

This arrangement seems to be desirable only on a locomotive of this kind which has short runs to make, where the rack is constantly in use.

In 1886–87 there was built the road from Puerto Cabello to Valencia in Venezuela. For the crossing of the high ridge of Las Trincheras between the two places a section of rack-railroad 3.8 kilometers in length was put in. The rack-rail on this line is in three bars, 22½ mm. thick, placed 40 mm. apart.

The locomotives are rack-rail engines only; they are carried on three pairs of bearing wheels, and have two driving axles carrying the toothed wheels. There are four cylinders, one pair to each driving axle.

The English Government in 1887 ordered for the military road through the Bolan Pass, in India, 11.3 kilometers of rack-rail, to be of the same dimensions and of equal strength with that used on the Harz Railroad. The locomotives are of similar construction and strength, with this improvement, that the axles for the toothed wheels are driven directly, without an auxiliary shaft, and the frame carrying these axles is fixed on the two forward adhesion axles without hangers.

The principal dimensions and particulars concerning these roads are given in the following table:

Road.	When built.	Gauge, meters.	Length in Kilometers. Rack-rail.	Length in Kilometers. Total.	Grade, Per Cent. Ordinary road.	Grade, Per Cent. Rack-rail road.	Least radius of curvature, meters.	Weight of locomotive, tons.	Weight of load, tons.
Harz	1884–86	1.435	7.8	30.5	2.5	6.0	180	56	120
Lehesten	1885	1.435	1.3	2.7	3.1	8.0	150	23	50
Oertelsbruck	1885	0.690	0.5	10.0	3.5	13.7	120	6	6
Puerto Cabello to Valencia	1886–87	1.067	3.8	56.0	......	8.0	180	38	60
Bolan Pass	1887–88	1.676	11.3	......	2.5	4.2	180	54	175

The next example of this system will be in Austria, where a concession has been granted for a branch line from Eisenerz to Vordernberg, which will be finished in 1890.

This Eisenerz-Vordernberg line will have a total length of 20 kilometers, of which 14.5 kilometers will have the rack-rail, which in this case will consist of two plates or bars 27 mm. thick. The heaviest grade worked by adhesion will be 2.5 per cent.; on the rack-rail section there will be grades as high as 6.8 per cent., or 359 ft. to the mile.

The locomotives will be similar in construction to those of the Harz Railroad, with several improvements of essential importance.

It will be remembered that Herr Abt's latest improvement consisted of an arrangement which was fully described in the article above referred to, by which a train can pass from the ordinary track upon the rack-rail section, and the rack engine can be put in operation, without stopping, so that the introduction of a short section of rack-rail in a road will cause no delay or stoppage.

NOTES ON RIVER CROSSINGS AND BRIDGE PIERS.

By M. Otagawa, M.E., Tokyo, Japan.

(*Continued from page 545.*)

VI.—FORM AND THICKNESS OF PIERS.

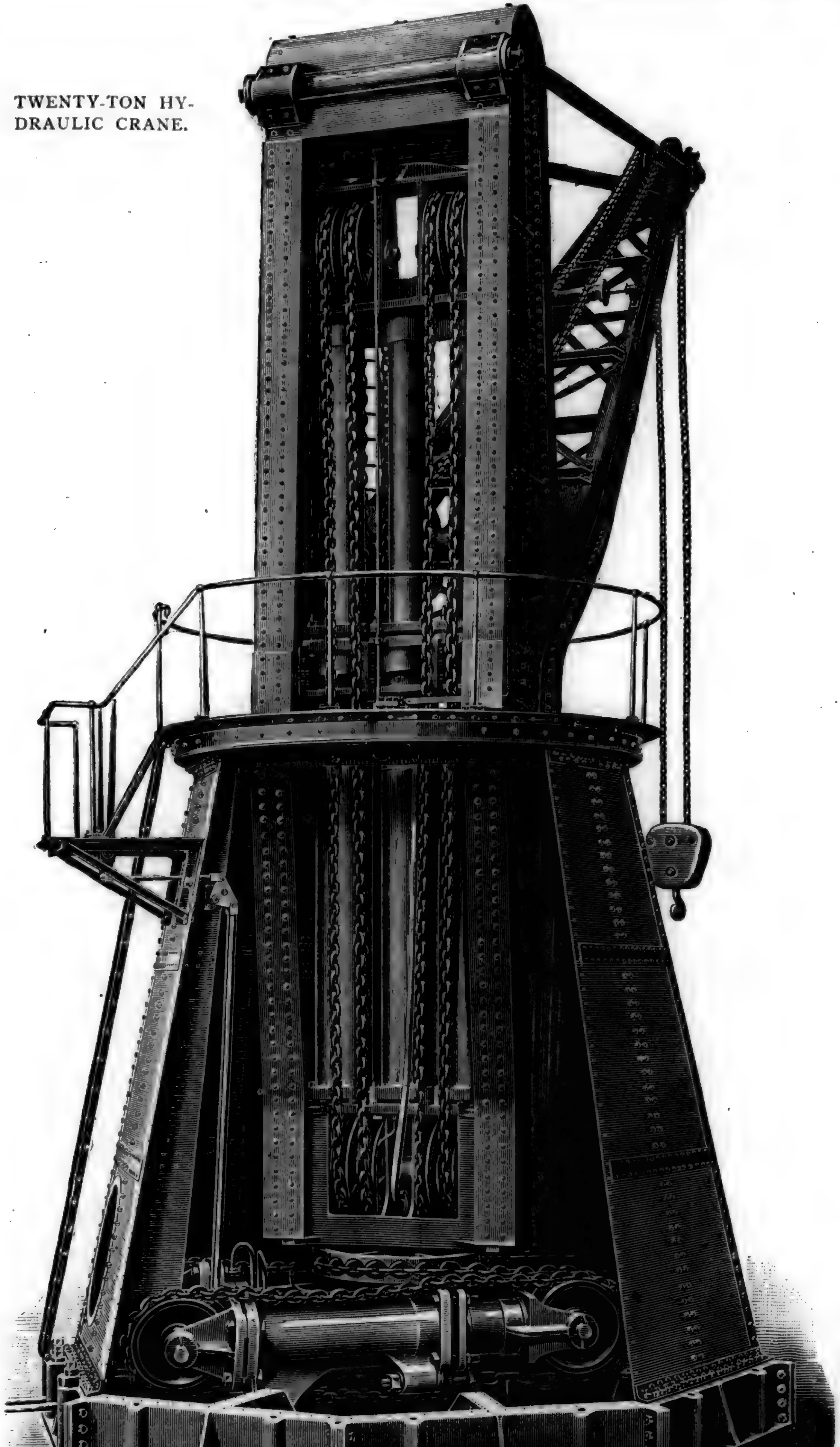
In order to allow a proper amount of water-way to a bridge, the thickness of piers should be as small as practicable consistent with stability. If the bridge has a water-way such that the relation between the resistance of the bed and the mean velocity of the current is not altered before the bridge is constructed, no damage results. But in cases where the piers or springings of the arches obstruct the current, there will be increased velocity, which produces a dangerous result. In order to avoid the undermining of the river-bed, which is the effect of contraction of the sectional area, attention must be paid not only to the size but to the form of the starling.

There are various forms of piers which are actually built. Our present object is to determine the most suitable shape of starling, as far as the obstruction is concerned. The problem is equally applicable to the head of a jetty as well as to the starling of a pier, on account of the similarity of the circumstances under which they exist. In determining the proper shape of piers, it must be borne in mind that masonry work when totally immersed in water weighs only three-fifths as much as in the air. The river-bed is porous to a certain extent, and there is an action like a spring, the elastic force of which is equivalent to the pressure of the depth of the river. Such being the case, if there be some means for the escape of such a force, the upward pressure will act against any structure which is within its reach, and the force is so great when such a void extends to the depth of four or five feet that it often lifts up an enormous weight.

In addition to the above, we have to consider the matter in other respects—*i.e.*, we have to arrange the piers so that they will not be damaged by the shocks of floating objects such as ice, timber, boats, etc. For this purpose great solidity must be given to the starlings, and at the same time their projecting angles must be neither too acute nor too flat, for in the former case they will soon wear away, and in the latter they are not suitable for opposing masses of ice. In order to reduce the contraction, the starlings should be made very long and terminate in a point. Thus, we see that it is impossible to satisfy the above conditions at the same time. According to the peculiar circumstance under which the pier is to be designed, proper consideration must be made. To prevent contraction as much as possible, the surface of the starling should not make an angle with the flanks of the pier, but the side faces must be continuous with the faces of the starlings. This condition can be fulfilled by making the starling a convex curve and the flanks tangent planes to the curve.

For the purpose of determining the best form of starlings, experiments have been made by many hydraulic engineers. The forms of starlings with which the experiments were made are rectangle, triangle (rectangular), triangle (equilateral), semi-circle, triangle (mixtilinear),

TWENTY-TON HYDRAULIC CRANE.



ellipse, triangle mixtilinear concave, etc. These experiments show that whenever the flanks of the pier are connected to the starling by a curve which is a tangent to them, the water does not surmount the springing of the arches, and there is no fall produced at the shoulder, but two other currents are formed by the side which surround the pier. The velocity in that case is not great, and the rapid currents are more remote from the pier. The elliptical pier is advantageous on account of producing less contraction compared with other forms. In the case of an equilateral triangular pier, the greatest fall occurs at the angle of the shoulder; but in a rectangular one, at a point a little removed from it. In the former there is a deficiency in solidity. The equilateral triangle mixtilinear has the combined advantages of producing the smallest amount of contraction, having at the same time sufficient solidity at the projecting angle. For the same reason an oval pier is also preferable.

Hitherto we have only considered the suitable form of piers with respect to the amount of contraction caused in the current. But we must not neglect another important function which it ought to perform, more especially in cold climates—*i.e.*, the starlings must be so designed as to be capable of breaking the ice. If this precaution be not taken, a large mass of ice is suspended in front of the piers, and scouring results. For the purpose of preventing such a difficulty the angles of the starlings must be made acute, and to insure solidity it is advisable to protect them by bands of iron or by iron bars placed in the masonry work.

The method adopted by Perronet for overcoming the difficulty resulting from ice for the bridge over the Neva at St. Petersburgh is this: The projecting edge of the starling was made so as to incline forward. Now the masses of ice which strike the pier have a tendency to mount along the edge of the pier. This being the case, their own weight acts on each side, and the result is that they are broken and are carried off by the current.

It is found by experience that as the water comes to the bridge it is locally elevated and gains greater velocity. But in passing below the bridge it recovers its original level and velocity. Although the form of starling down stream is a matter of secondary importance, still the neglect of it produces stagnant water, which is to be occupied by it, and the result is that undermining takes place above the bridge. In order, therefore, to get the full benefit from the starling, it must be provided on both sides of the pier.

What was mentioned in the above paragraphs applies with equal force to arched bridges as well as other types of bridge. But in the case of an arched bridge, when the water level is above the springing of the arch the circumstances altogether vary. In that case we must also consider the manner in which the intrados of the arch is connected with the face of starlings more particularly than the form of the starling itself, for then the latter has little to do with contraction, while the former is the principal element of the obstruction.

If the pier of an arched bridge be designed to be stable when the thrust of the arch comes from one side only—*i.e.*, an abutment pier be adopted, then the thickness ranges from one-fourth to one-tenth of the span. It thus occupies an enormous space. If the arches be built symmetrically with respect to a pier during its construction, the pier may be thinner. According to Dr. Rankine, the thickness for an ordinary pier is said to range from one-sixth to one-seventh of the span.

In bridging over a stream, almost every new situation requires a special design. The superstructure and the piers are two principal parts into which the design may be divided. Their relative importance can be determined by the physical character of the river, the nature of the river-bed, and other conditions of the site. The cost of the superstructure increases as the length of the spans. Therefore, if the bed of the river is of a reliable nature, such as rock, gravel, or hard clay, in which the foundations can be easily constructed, a short span would be economical. But in many cases it is difficult to build piers under water, especially when the foundation is hard and the current is rapid. The most economical span should be decided upon in each particular site. But in navigable rivers or in rivers which are subject to heavy floods, it is necessary to diminish the number of spans in the stream as much as possible. In some cases the number of piers must be reduced not only from the costly nature of the foundations, but also from the shortness of the season suitable for erecting them.

VII.—EXAMPLES IN JAPANESE PRACTICE.

I now propose to conclude these notes with some remarks bearing upon the cases of bridges which were actually built over large rivers in the neighborhood of Tokyo. When railroads were first introduced into Japan, the most difficult case was the Rokujo River crossing on the Tokyo-Yokohama line. The river was first crossed by a temporary wooden bridge. In selecting a site for the new bridge, which was laid out so as not to interfere with the original one, the line was diverted, with short curves on both sides of the river, and the new alignment was less oblique to the main channel of the river than the original one—that is to say, the angle of obliquity is 75°. It was further considered desirable that greater headway should be given than had been allowed in the original bridge for excessive floods, and an increase of the gradients on both side of the river was made. The rail-level thus attained was 20 ft. above the ordinary high-water mark and 6 ft. above the highest known flood level.

Before the Rokujo Bridge was constructed a careful examination was made with respect to the flood discharge and the general regimen of the river, from which the proper length of the bridge was estimated. The dimensions are as follows, measuring from the north abutment:

23 spans of 40 ft. clear	=	920 ft.
1 span " 38 " "	=	38 "
6 spans " 92 " "	=	552 "
Total water-way	=	1,510 ft.
23 piers 4 ft. thick	=	92 ft.
6 " 8 " diameter	=	48 "
Total space between abutments,	=	1,650 ft.

Thus, the piers occupy about 9 per cent. of the total space between the abutments.

Next, for the bridge over the Arakawa, already referred to, we have, measuring from the north abutment:

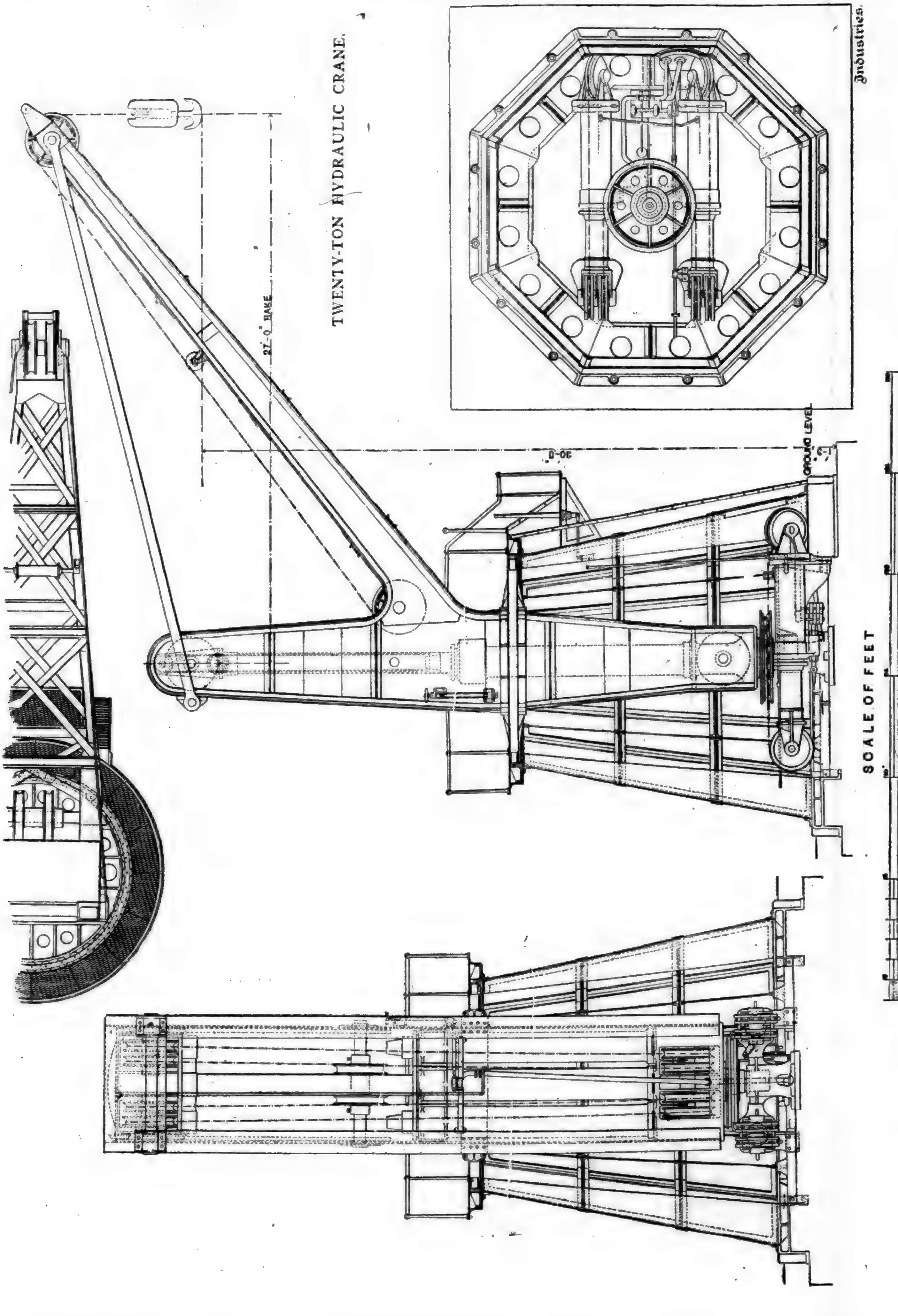
10 spans of 50 ft. clear	=	500 ft.
4 " " 94½ " "	=	378 "
38 " " 50 " "	=	1,900 "
Total water-way	=	2,778 ft.
9 piers 4 ft. 10½ in. thick	=	43 ft. 10½ in.
5 " 6 " thick on brick wells 12 ft. diameter	=	30 " 0 "
37 " 4 " 10½ in. thick	=	180 " 4½ "
Total space between abutments	=	3,032 ft. 3 in.

In this case the piers occupy a little more than 8 per cent. of the total space between the abutments.

Lastly, for the road bridge over the River Tone at Maebashi,* which I constructed with my friend, Mr. K. Shibuya, the following are the dimensions, measuring from the east abutment, the road level being 40 ft. above ordinary water level:

2 spans of Howe truss, each 90 ft.	=	180 ft.
10 " " beam bridge " 42 "	=	420 "
Total water-way	=	600 ft.
2 cast-iron piers, 3 ft. diameter, with bracing of 1 ft. thick	=	8 ft.
10 wooden piers, 1.5 ft. diameter, with bracing of 7 ft. thick	=	22 "
Total space between abutments	=	630 ft.

* For a description of this bridge, see RAILROAD AND ENGINEERING JOURNAL, April, 1887.



TWENTY-TON HYDRAULIC CRANE.

Thus the piers in this case occupy about 5 per cent. of the total space between abutments.

As has been explained in the previous paragraphs, in obstructing a certain portion of water-way by piers, the river has a tendency to compensate for its lost area by undermining the bed, so that it is often necessary to build some form of protection through the whole width of the bottom ; then every part shares the uniform resistance and the current does not damage any one pier more than another. For this purpose I have constructed crib-works, fascine-works, stone pitchings, "jakago" (basket-works of bamboo filled with stones), etc., round the pier and also through the width of the river, which answered the purpose well.

TWENTY-TON HYDRAULIC CRANE.

(From *Industries.*)

WE illustrate herewith a hydraulic crane, constructed by Messrs. Stothert & Pitt, Limited, engineers, Bath, for the State of Kattywar, India, which is capable of lifting 20 tons through a height of 40 ft., the distance of the hook from the center of the pillar being 27 ft. The lifting power is effected by three cylinders and rams placed vertically between the sides of the revolving pillar. The rams have a diameter of 12¾ in., and a stroke of 10 ft., being one-fourth of the range of lift given to the chain hook. In order to economize water when dealing with light loads, the lifting power may be varied by putting pressure on one, two, or three of the rams, as required, thus giving three powers of lifting, for loads up to 7, 14, or 20 tons respectively, the water pressure being 700 lbs. per square inch. The lifting chain is double, with an equalizing pulley and counterweight, to overhaul the slack, placed immediately above the hook. The revolving pillar with jib is rotated by two cylinders and rams placed horizontally in the basement of the pedestal on either side of the central footstep. These are geared by means of chains to a cup drum fixed to the foot of the pillar, and have a length of stroke sufficient to turn the crane through a complete circle in either direction. The valves are placed in the basement of the pedestal, and all the operations of working, lifting, lowering, and slewing in either direction, are performed by means of two hand levers. These levers are placed on a working platform near the top of the pedestal, in a position which gives the driver a good view of the load.

The pedestal is constructed of steel plates and angles, octagonal in shape, and stiffened by vertical ribs and horizontal gussets. It is bolted down to a massive cast-iron base plate, and carries at its upper end a cast-iron roller path, on which a live ring of rollers runs. The revolving pillar and jib are constructed of steel, and the height of the jib pulley above the level of the wharf on which the crane stands is 37 ft. The hydraulic pressure is obtained from an accumulator through the existing mains, but a set of hydraulic pumps were supplied, driven by a portable engine, for working the crane at times when the supply from the mains is not available.

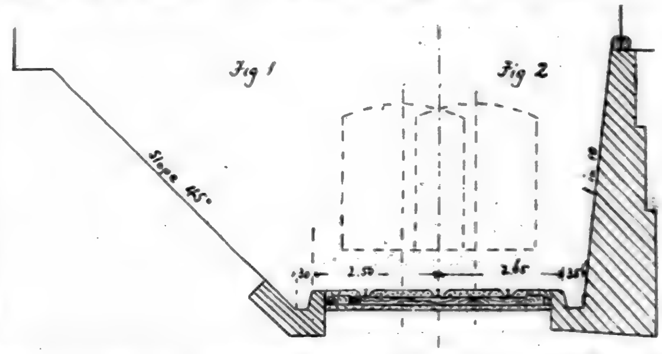
We are informed that the crane was tested with these pumps at the makers' works, with a load of 20 tons, and all the operations were satisfactorily performed. The crane was ordered by Mr. R. Proctor Sims, C.E., the Superintending Engineer to the State of Kattywar, and the work was carried out in England under the superintendence of Mr. J. R. Manning, C.E.

A FRENCH CABLE RAILROAD.

(From *Le Genie Civil.*)

THERE is a considerable movement of passengers daily between the center of the city of Lyons and the heights of Croix-Rousse. To provide for this in some degree there was built in 1878 a cable railroad from Fourviere to Saint-Just. This has been of great service to the city, but 10 years' experience has shown that it served really only about one-third of the people who every day go to the Croix-Rousse. The rest of the movement passed by way of the Grande Cote and Saint Sebastian. It was therefore decided that it would pay to build a second cable road near Mt. Saint Sebastian, starting from the Croix-Paquet, which is a center toward which there is a large daily movement of passengers. A concession was accordingly obtained from the Government in December, 1887, for such a line, as a railroad of local interest.

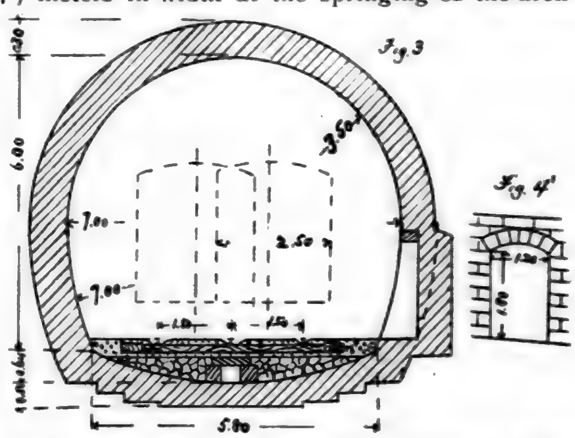
The line starts from the Croix-Paquet at one corner of the Public Garden and at the meeting of three of the principal streets of the city. The road consists of two tangents united by a curve. One of these tangents is 436.10 meters



and the other 48.72 meters in length, and the entire length of the line is 518.81 meters. The height above water-level at the starting point is 173.03 meters, and that of the upper end of the road is 249.43 meters, so that the vertical rise is 76.40 meters. The radius of the curve is 250 meters, and the maximum grade is 17.2 per cent.

Leaving the starting point, the line crosses the Public Garden from the Croix-Paquet station ; this station faces on an entrance court, which is in an excavation of 43 meters in length, bounded partly by a retaining wall and partly by an earth-bank, the slopes being sodded and planted with trees, in order not to interfere with the general appearance of the Public Garden. Just beyond the station foot passengers can cross the track on a handsome iron bridge.

The line then passes at once into a tunnel of arched section, 7 meters in width at the springing of the arch and



263 meters in horizontal length. The floor or bottom of the tunnel is an arc of a circle 7 meters radius. This tunnel passes under several streets, and the line finally leaves it and returns to the open air on private property. From the upper portal of the tunnel it is in an open cut, sometimes with retaining walls and sometimes with a bank having a slope of 45°.

The necessity of having the terminal station facing on the Boulevard Croix-Rousse embodies the necessity of a curve of 250 radius, joining the two tangents.

The road is constructed for two tracks, but, in order to diminish as much as possible the expense, and also to reduce the space taken from the Public Garden, the two tracks are laid close together, as has been done on the cable railroad at Glion, in Switzerland, where the interval between the two tracks is only 0.131 meter. Here this interval has been suppressed altogether, except for a dis-

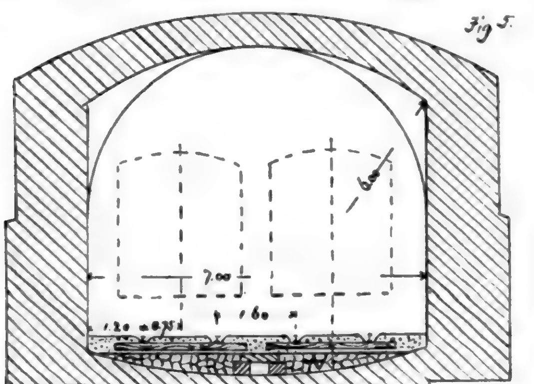
tance of about 38 meters at the Croix-Paquet station and at a passing-place about half-way, where an interval is introduced and a double track made for a distance of 52 meters. At other points three rails are laid, the center rail serving for both tracks, as shown in figs. 1, 2, and 3 herewith; at the stations and at the passing-place the interval between the two tracks is 1.60 meters, as shown in fig. 5, the ends of this double track being joined to the three-railed line by curves of 100 meter radius.

There are two stations, known as the Lyons and the Croix-Rousse, one at each terminus. A third one may be established at the central point or passing-place hereafter, but it is not yet considered necessary. The stations are used both for passengers and freight. At the Lyons station, two lateral platforms are provided for passengers, who enter by doors in the main front and pass out through side entrances, one at each side of the building.

For freight or for carriages open trucks or flat cars are provided, and vehicles can be driven upon these trucks, entering the station through special gates. Freight is not carried on Sundays or holidays, and the freight trucks are then transformed into passenger cars by means of movable seats and railings placed on the car.

The station buildings are of iron with brick foundations.

The cars, both passenger and freight, have their floors horizontal at the stations, and in passing over the road



are, of course, inclined 0.172 mm. per meter on the highest grade. On one end of the trucks provided for carrying vehicles is placed a turn-table, on which the wheels of the wagon or carriage will rest, so that when the car is run into the station the horse, who stands on the fixed end of the truck, can without effort or danger turn the vehicle in the proper direction and pass off the car to the exit from the station. At the end of the station at the starting point there is provided a car-house, large enough to contain a freight truck and a passenger car. These cars when needed are put in service by a special arrangement for switching.

The engines which drive the cable are placed in a special building and the cable is carried over drums in a subterranean conduit. The engineer is so placed that he can see the trains in motion from the time they pass out of the tunnel until they arrive at the upper station.

In the accompanying sketches, which are given as of interest in showing the manner in which the work is carried out, fig. 1 is a half-section of the road in open cut, with earth-bank; fig. 2 a half-section of the open cut with retaining walls; fig. 3 a section of the tunnel; fig. 4 shows the recess provided in the tunnel for workmen, etc., and fig. 5 is a section of the tunnel at the passing-place or central point, where a space is left for a double track. The profile and plan of the road are not given, being very simple and easily understood from the description.

THE VYRNWY DAM.

(Condensed from *Industries*.)

THE accompanying illustrations show the dam on the Vyrnwy River, in Wales, built in connection with the works for furnishing an additional supply of water to the city of Liverpool. This dam forms a lake about 4¾ miles long, the total surface area when full being 1,121 acres and the greatest depth 84 ft., the storage capacity being about 12,000,000,000 gallons.

As shown by the illustrations, the dam extends across a narrow valley, its total 1,173 ft. To determine the exact position of the rock at the site chosen for the dam 13 shafts were sunk and 177 borings were made through the alluvial

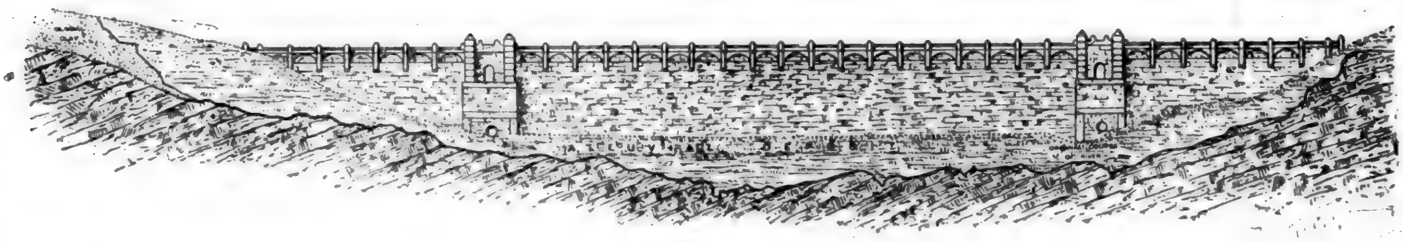


Fig. 1.

deposit, and when the rock was subsequently bared it was found to extend, as had been anticipated, right across the valley. The strata dip toward the upper end of the valley. When the rock was exposed, the glacial action was very apparent, for the outcrops of the strata had been crushed off by the flowing mass, and immense masses of the rock, some several hundred tons in weight, were found lying on the top. These, however, were all removed, and the dam rests upon the solid rock; all doubtful surfaces and long projecting outcrops having been quarried out. A cross-section of the valley, on the lower side of and near to the dam, is shown in fig. 1, where the shape of the surface of the rock, the alluvial deposit, and the back of the dam is clearly shown. A cross-section of the dam is shown in fig. 2, with the leading dimensions of a typical section, which are as follows: Width of base outside toes, 117.75 ft.; height from base to top of dam at overflow, 128 ft.; height to top string course of viaduct, 136 ft.; height from base to back-water level, 45 ft.; maximum depth from top of dam to lake bottom, 84 ft. The area of the typical section is 8,972 sq. ft.; its weight per lineal foot is about 645 tons; its specific gravity is 2.57; its center of gravity is 47.59 ft. above the base, a vertical line from it cutting the base 47.53 ft. from the inner toe, and 70.22 ft. from the outer toe. From Mr. Deacon's calculation, it appears that when the lake is empty the maximum pressure occurs at the inner toe, and is equal to 8.7 tons per square foot, that on the outer toe being only 2.26 tons per square foot. When the lake is full, the resultant pressure gives a maximum pressure at the outer toe of 6¼ tons per square foot, and under no possible condition could it exceed 15¼ tons per square foot. The total length of the dam is 1,173 ft., and above the overflow level is constructed a viaduct 22 ft. wide on stone arches, through which will flow the excess of water into the basin at the back of the wall, and on to the River Vyrnwy. The east end of the dam is built into the solid rock; but as the rock was too far away at the west end, the joint will be made with puddled clay.

The class of masonry adopted is generally known as "Cyclopean rubble," the stone—a clay slate of the Caradoc group of the Lower Silurian—being obtained from the quarry, about a mile from the site of the dam. The stone is a hard, durable, dark gray stone, weighing 2.06 tons per cubic yard, the cleavage being very irregular, making it almost impossible to obtain a rectangular block. The maximum weight of the blocks is about eight tons, and each stone is carefully scrubbed and washed with water, at a pressure of 140 lbs. per square inch, before leaving the quarry. The bed of the valley contains excellent sand

for cement, mortar, and gravel for the concrete, the following being its chemical analysis :

Water	2.3
Silica (combined)	65.7
Oxide of iron as silicates	12.4
Alumina	13.4
Lime	2.4
Magnesia	0.68
Alkalies	3.8
Total	100.68
Errors	.68
Total	100.00

It was afterward found that refuse from the quarry, if crushed and mixed with the natural sand in the proportion of two to one, made a stronger mortar ; and the sand for the mortar has been made from this mixture since 1884. Very ingenious apparatus for washing the sand was devised by Mr. Deacon, by means of which the clean water entered the end of the rotating cylinders at which the washed sand left it ; the internal screws pushing the material to the top of the inclined cylinder against the water, falling by gravity. The dirty water thus left the cylinder with the refuse.

The whole of the mortar and concrete is made of Portland cement, made to the following specification : 90 per cent. of the cement to pass through a sieve with sixty brass wires per lineal inch weighing 3¾ oz. per square foot. Briquettes, eight days after being moulded and kept in water from the second to the seventh day, to withstand for an hour, without fracture, a weight of 560 lbs. per square inch. The actual average test of over 1,000 briquettes has proved to be 700 lbs. per square inch.

Three cubes of the rock were tested by Professor Unwin, who found the mean crushing pressure of three test blocks, 3 in. along each side, to be 807.7 tons per square foot. He also tested a number of cement blocks with the following results :

Age of block in months.	Mean strength per sq. ft. Tons.
32–36	170.4
28½–29½	161.9
20–23	169.2
8	128.7
5	122.4
2	90.6

The blocks were placed between millboard and lead.

Near each end of the dam a culvert, 15 ft. diameter, was constructed through the dam to carry off the storm water during construction. These culverts have since been built up, an iron pipe 2 ft. 6 in. diameter being introduced and built round solid ; these pipes lead into a valve chamber, and out at the back of the wall, and can be used as storm outlets. The compensation water is drawn from one of these pipes at the west end of the dam, and is fed by an 18-in. pipe into the various gauging chambers after having passed through a specially designed equilibrium valve.

The total length of the aqueduct, from the straining tower in the lake to the Prescot Reservoir, is about 68¼ miles. It consists of a succession of tunnels, and three lines of pipes capable of passing 40,000,000 gallons per day. The tunnels are already made of the full capacity, being 7 ft. diameter, but only one line of pipes will be laid for the present ; the other two lines are to be laid when the auxiliary supplies from the Marchnant and the Cowny are connected by tunnels to the reservoir. The aqueduct commences at the straining tower, with a concrete culvert about 765 yards long, built below the bed of the reservoir ; it then enters the Hirnant Tunnel, 2⅜ miles in length, regulating valves being placed at the inlet. From the outlet the water enters the pipes, 42½ in. diameter, for a distance of about seven miles, the pipes being underground, except when they pass a stream near the village of Llanrhaiadryn-Mochnant, and will discharge the water into the balancing reservoir at Parc Uchaf, the capacity of which is 2,000,000 gallons. The pipes then continue underground for 6½ miles, when they enter the Cynynion Tunnel, 4,620 ft. in length, and passing over the narrow valley of Morda, enter the Llanforda Tunnel, nearly a mile in length, and discharge into the reservoir at Oswestry, which has a capacity of 46,112,000 gallons. The water is then passed through the sand filtration beds and into a clear water reservoir. If necessary, the water can be supplied to Liverpool without passing the filter beds. From the clear water reservoir the water is conveyed in pipes for 17¼ miles underground to Malpas, except at the valley of the Wych Brook, which is crossed by nine arches. In this length the Shropshire Union Canal and two branches of the Great Western Railway are crossed, the operation at the former presenting great difficulties, owing to the yielding nature of the ground. A balancing reservoir is built

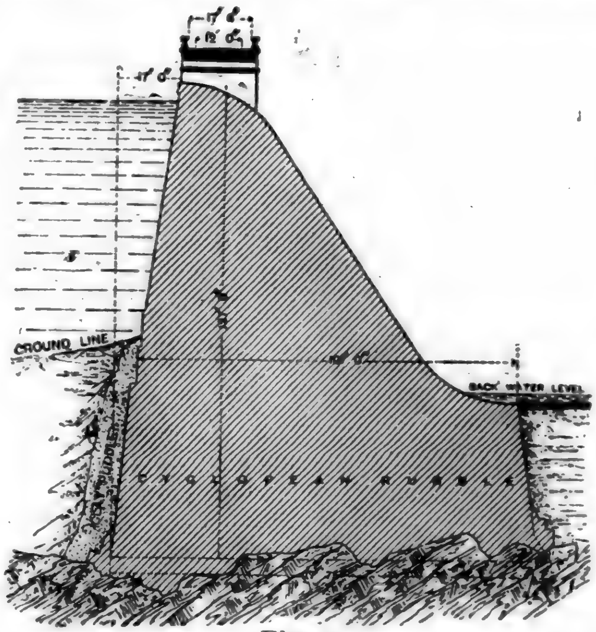


Fig. 2.

at Oat Hill, near Malpas, and from this point the pipes are laid underground for 11¾ miles to the hill near Cotebrook, upon which is built another balancing reservoir, having a capacity of 2,000,000 gallons. Upon this section two branches of the London & Northwestern Railway are crossed, and the Shropshire Union Canal near Beeston. The pipes then pass underground for 11 miles to Norton, and as the hill at this point is lower than the hydraulic gradient, it has been necessary to build a water-tower. This section crosses the West Cheshire Railway near Delamere, the London & Northwestern Railway at Tatton Weaver, and the River Weaver. The method of crossing the River Weaver is by sinking steel pipes into the bed of the river and covering them with concrete. The tower at Norton is of novel construction and presents several interesting features. The next length of 9¼ miles to the existing reservoir at Prescot is a most difficult section, for it passes, wholly underground, the Bridgewater Canal near Norton, the Mersey & Irwell Canal, and the River Mersey three miles above Runcorn ; the Sankey Canal near Fiddler's Ferry, the London & Northwestern Railway and several branches of it, and of the Sheffield & Midland Joint Railway.

The Corporation wished to lay the pipes under the Mersey in the bed of the river, of a sufficient depth underground to be quite beyond the reach of anything which might interfere with the navigation. This plan was strongly objected to by the Conservators of the Mersey and by the Ship Canal Company. After a long trial, the Board of Trade required the pipes to be laid in a tunnel under the bed of the river. This tunnel is constructed of cast-iron rings, 9 ft. internal diameter ; vertical shafts are sunk at each side of the river, 9 ft. internal diameter, forming the tunnel proper, which has a slight fall to the north side of the river for drainage purposes. The cast-iron rings in the tunnel are in short lengths—2 ft. 6 in.—for facility of construction. The water mains under the Weaver and the Mersey are made of steel plates riveted together.

The straining tower at the commencement of the aqueduct is a most interesting structure, and the details of its construction and elaborate apparatus for regulating the

flow, and the cleansing automatically of the filters, have been most carefully designed and worked out, the whole arrangement being entirely novel and ingenious.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer.*)

(*Continued from page* 560.)

II.—THE REMERY & GAUTIER APPARATUS.

In the installation of the signal posts, which Messrs. Remery & Gautier have made on the Northern Railway system in France, there are some new combinations to which it seems to us that it would be well to call attention. The principle of this arrangement rests on the use of the interlocking blocks *j k l*, shown in figs. 17 and 18, which are made movable and which are bevelled on the ends, placed in slides, *V*, and held between the horizontal bars *B C D*, etc., which are moved by ordinary slotted levers of the Saxby type. In the situation shown in fig. 17, if the lever *G* is moved the block *l* is moved by its bevelled end toward the left and the bar *F*, the slot in which corresponds to the block *k*; if, on the other hand, the lever *E* is changed, the block *k* not being able to move, the bars *D* and *F* are fixed by the blocks *j* and *k*. We have then between the four levers mentioned the following interlocking relation: *F* normal or reversed is interlocked by *D* normal if *B* and *G* are reversed.

It will be seen that we can thus obtain certain combinations between *n* levers, sufficient allowance being made for the frictional resistance shown by the bevelled ends of the blocks against the slots in the levers, and also for the

Fig. 17.

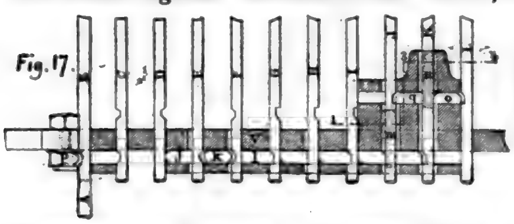
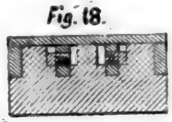


Fig. 18.



transverse oscillation of the bars, which in principle can only be moved in a longitudinal direction, but which can nevertheless hardly be made to fit perfectly in the slots.

An arrangement of this kind exists at the station of Don-Sainghin on the Lille-Bethune line, where the problem presented was under the following conditions, indicated in fig. 19. A signal 4 controls the starting of the trains, and should interlock with the switches 10, 12, and 14. The most complicated combination presented is that where the departure takes place over the switch 14, because it is then necessary that the signal 4 could only interlock with the switch 14 when 10 and 12 are reversed.

The use of the three blocks *a b c*, fig. 20, permits us to make the following combination: If we reverse 10 the block *a*, moved by its bevelled end, displaces the bar 4. This moves the block *B* into the slot 12, and 14 is only interlocked when 12 has been reversed; then, in order to move the lever 14, it is necessary first to reverse 4, that is to say, to put the signal at *Stop*; the slot in this bar giving play to the block *a*, the bar 14 can be displaced, moving the blocks *c* and *b*, and thus causing the bars 12 and 14 to oscillate.

The case that we have just cited is sufficiently simple, and is that in which the same bar, entering only into a relation of interlocking, need be moved transversely only in one direction. It may happen, for example, that we have at the same time the two relations (figs. 17 and 20): if JR, IN and HR : LN.

In this case *K*, which is not displaced transversely in the first relation, should be rendered movable in the second. The makers have provided for this necessity by placing in mortises made at the end of the bars *J* and *K* pieces *m n* making a lug which fills the space on either side of the bar in such a way as to limit its oscillation. If, in fact, we commence by reversing *K* the end of the piece *n* moves the block *o* in the slot in *L*; but *L* is not interlocked, for if we reverse it *o* returns to its former position, displacing the piece *n*, which moves the block *q*, and this movement is possible only as long as *J* is normal. The same relation exists, on the other hand, between *I*, *J*, and *K*, thanks to the movable piece *m*. It may be seen, without enlarging further, to what a variety of combinations the use of these blocks and sliding pieces will lend itself. The idea is evidently taken from the cam principle used by M. Dujour.

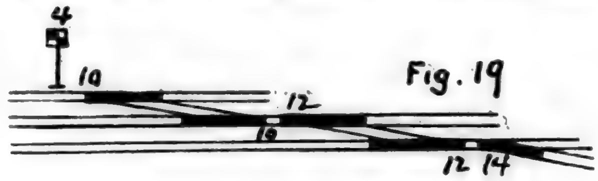
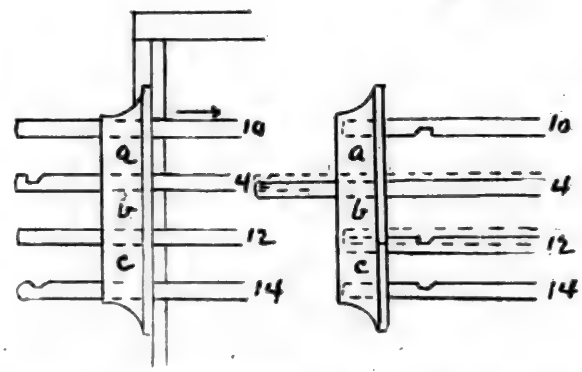


Fig. 19

Fig. 20.



In cases where bars situated above the slotted levers have interlocking relations with other bars situated below them, the communication between the two groups *A B*, fig. 21, is established by a connecting rod *p*, at the ends of which are fixed bevelled blocks, which enter into play with the bars *A* and *B*. The movement of the blocks is then opposite or parallel, according as the bars are placed on the same side or on opposite sides, with relation to the connecting rod.

III.—THE FROITZHEIM SYSTEM.

At the Electrical Exhibition in Vienna in 1883, there was shown an apparatus of the Froitzheim system, which is in use at the West End Station in Berlin, at Cassel, Potsdam, Dessau, and elsewhere, and which deserves attention,

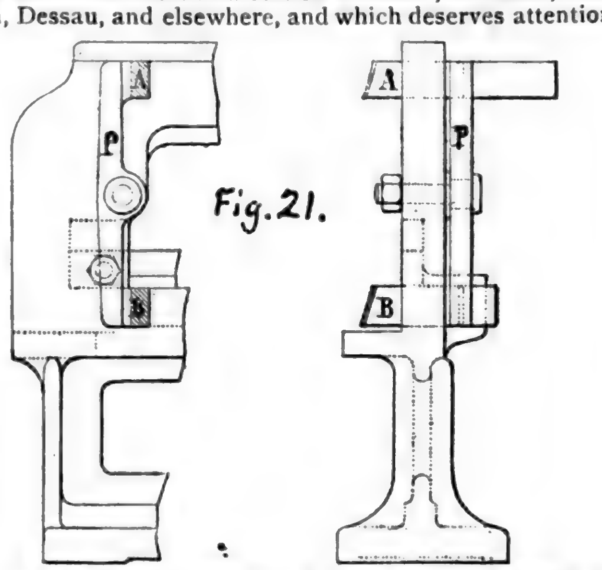


Fig. 21.

because of its wide differences from the types which we have heretofore described.

It may be used for connections by wires, as well as for rigid connections, and might also be employed in connection with the apparatus of the block system (Hattemer & Kohlfurst) in such a way that, according to the arrangements used in the German stations, we can from the central post situated in the station building lock the levers worked by the signalmen at the outer signal stations.

We will consider first a central apparatus for four signals and eight switches, the first worked through a double

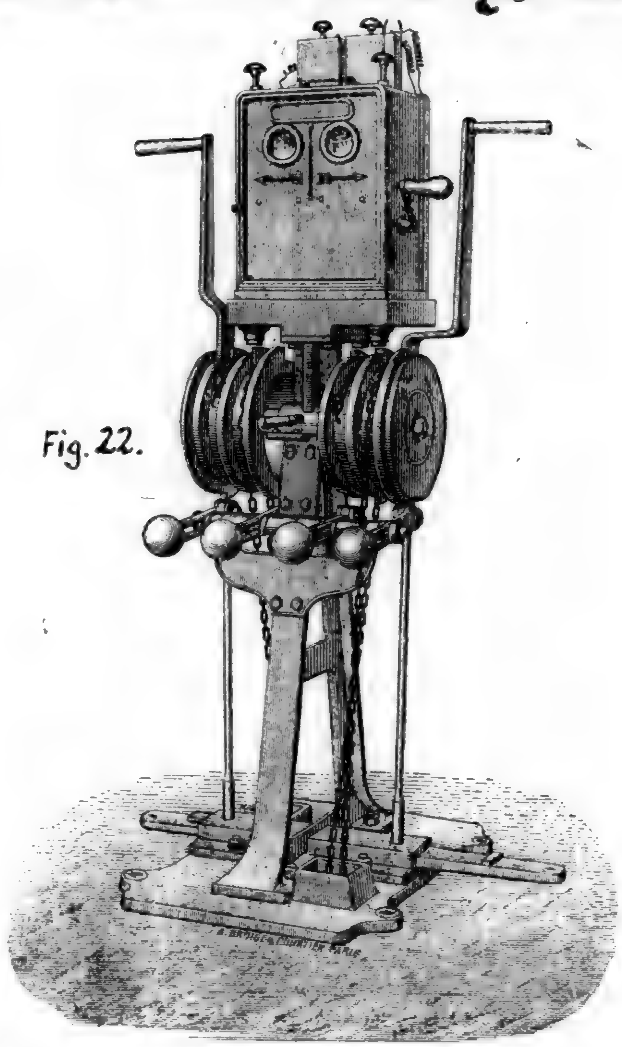


Fig. 22.

wire, the others attached to their levers by rigid connections.

To work the signals it is necessary to make a half revolution of the pulleys *D*, figs. 24 and 25, by means of a handle *A* fixed to the shaft. Chains *n* rolled on these pulleys pass over the bearing pulleys *D'* and transmit the movement of the shaft to the signal. But the rotation of the pulleys *D* can only take place in one direction, when we have first lifted the handle *J* to loosen the ratchet wheel *a'* placed on the circumference of the pulley *D*. By this movement we cause the rods *a* to descend; these through the levers b^1 b^2 b^4 work on horizontal bars, carrying lugs like *c*; in front of these lugs other bars f^2 can be moved in a perpendicular direction and will uncover, in the fixed bars f^1, openings corresponding to these lugs *c*;

Fig. 23.

the interlocking then takes place and is reciprocal; the movable bars f^2 are displaced by reversing the switch levers *B* (fig. 25) furnished with the points l^1 l^2 on which a slight pressure through the lever *K* suffices to cause the movement of the bars to begin. Above these signal levers is a box *M*, which contains the switches bringing into use the electrical connections, which permit us to control the movement, if the signal has properly followed the working of the lever.

As we see, this type of apparatus can hardly be applied except for simple interlocking combinations. The use of compound interlockings would produce too great a complication; moreover, it will be seen that the working of the signal lever requires the use of two hands, one at the crank, the other at the catch handle.

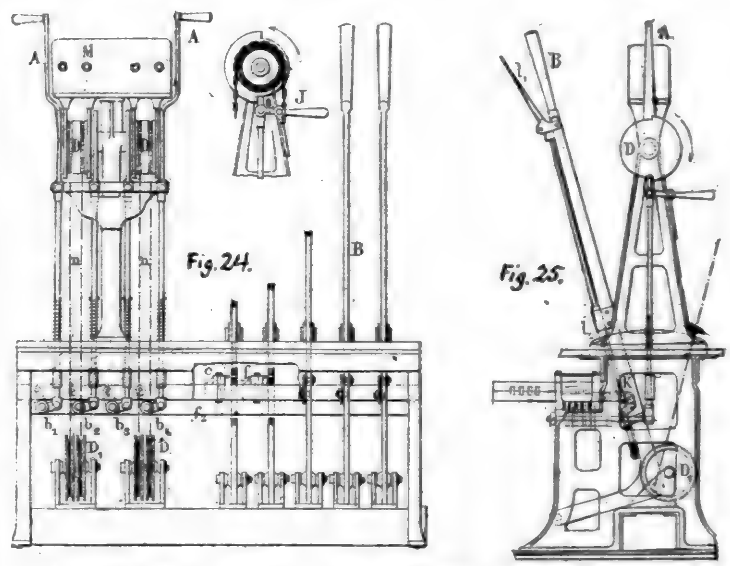


Fig. 24. Fig. 25.

Against these smaller inconveniences there may be placed the advantages which this apparatus has, that it may be used in direct connection with the block signals which allow us to stop electrically the working of the signal levers. As may be seen by examining fig. 22, a lock can be attached to the pulleys by which the signals are reversed, and can be so arranged that they will only be set free when the current necessary to draw back the lock has been sent from the central signal station. We will not enlarge further on these details, which belong more to the block than to the interlocking system.

If we consider the signal posts with wire connections, we find that all the levers are worked by pulleys, and the

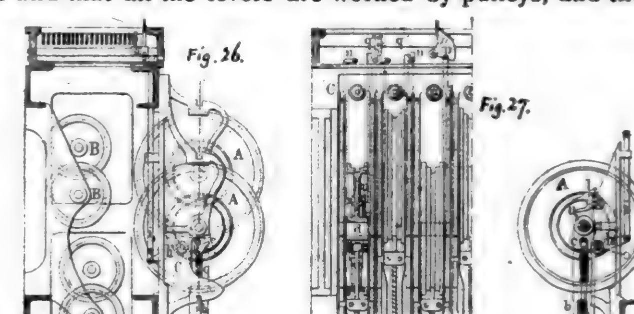


Fig. 26. Fig. 27.

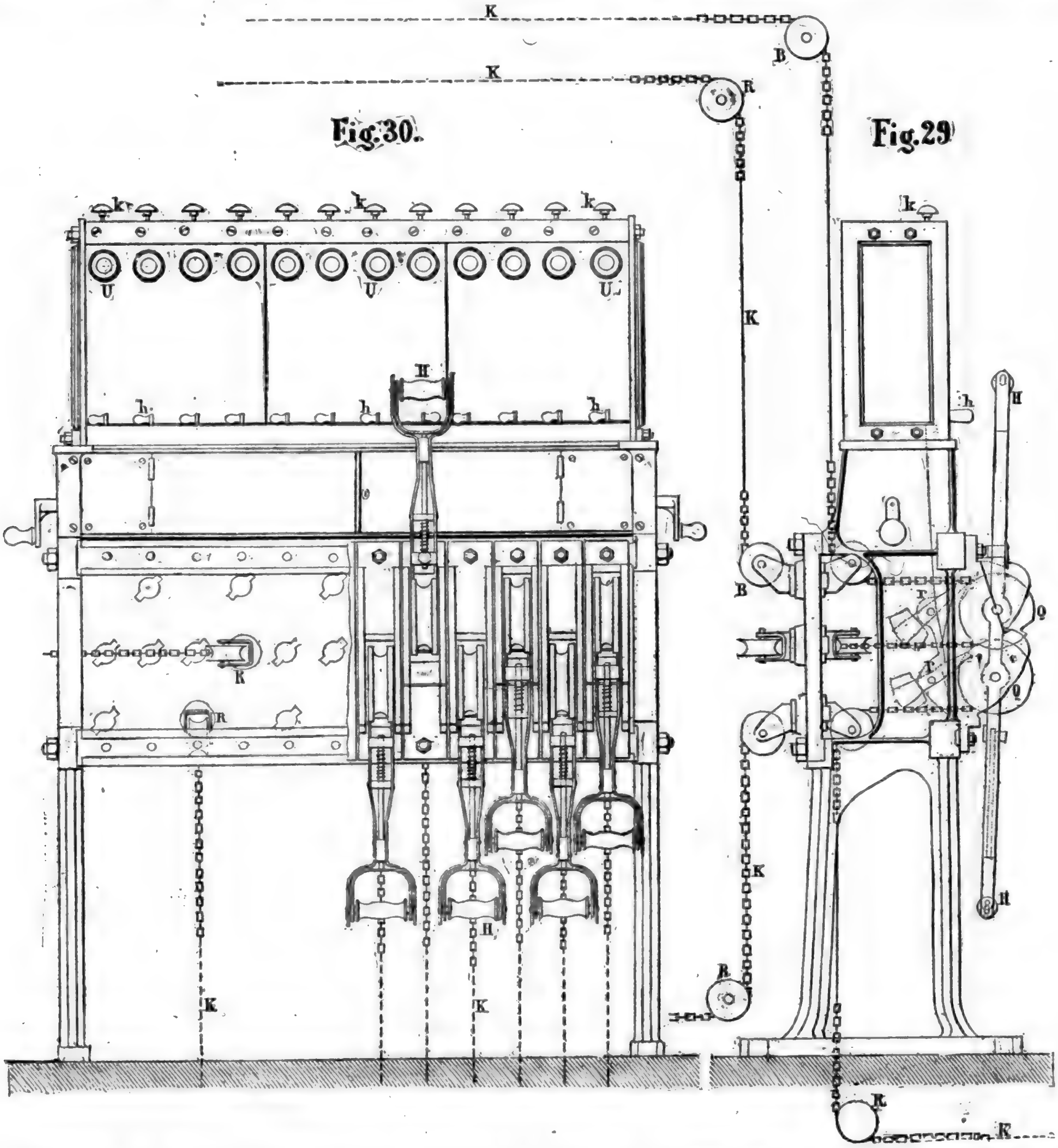
interlocking arrangement shows a disposition altogether different from that which we have described.

On a cast-iron stand *C*, figs. 26 and 27, are mounted vertical pulleys *A* furnished with grooves over which pass the chains connected with the wires by which the signals and switches are worked, and passing over carrying pulleys like *B*. On the shaft *d* of each pulley there is fixed a lever *z*, arranged with a point *a*; to work the apparatus we must cause the corresponding pulley to make half a revolution by raising the lever *z*, as shown in fig. 26; in the normal position these levers *z* are, as shown in the cut, thrown down. Their extreme positions are fixed by the

stops d, which at the lower end of their course engage in slots made in the stand C. By moving the point a vertically we disengage the lug from the slot, and the lever can then be reversed if it is not otherwise interlocked.

The interlocking table, situated on the upper part of the apparatus, connects with the levers through bell-cranks

Below each of the rods $i\ i^1$ of a switch lever are found pieces which make a quarter turn when the rod is raised. In the opposite case the rods like i^2 of the signal levers are joined to segments p, moving around the shaft u in such a way as to cause the horizontal displacement of the bars q. Under these bars are mounted others q^1, which abut against



$i\ i^1$. Whenever we draw at the point a the piston-rod q, which works the point b, is lowered, and the point e, which is carried at its end, moves the piece u, figs. 27 and 28, the oscillation of which is communicated to the lever h in such a way that the bell-crank i takes a vertical oscillating movement, which causes the necessary interlocking. Grooves l^2 permit the slide of the fingers with which the piece u is provided.

The signal levers have only a single connection h placed on one side of the pulley A, the switch levers have a second connection similar to the first and placed on the other side; the first acts in the normal position, and the other in the reversed position of the switch. In this last case the piece u^1 acts on the vertical bar I through the jointed lever $l\ m$, fig. 23, which is arranged in such a manner that if i^1, corresponding to the normal position, is raised, i, which corresponds to the reversed position, is lowered, and *vice versa*.

the pieces n depending from the switches, or placed below them, and in consequence fix the switch in one or the other of its positions, as the case may be.

This arrangement is a little complicated; nevertheless, it solves in a sufficient way the problem of simple interlocking, and only requires the use of one hand by the signalman.

IV.—THE SIEMENS–HALSKE SYSTEM.

The central signal stations of MM. Siemens and Halske did not contain an interlocking system, in the strict sense of the word; they are stations of the ordinary type of the block system, arranged to interlock some switches with signals, the levers of which are made immovable by induction currents, sent out from a signal station, which is always placed close to the office of the station-master. But this interlocking is not done in the cabin of the signalman, for the reason that in Germany it is not usual to con-

centrate the working at a distance from the switches; by orders of the general administration the levers of these remain scattered around the station, and at the end of the lever of each switch there is a locking bolt which makes it impossible for the switch to be opened by a switchman

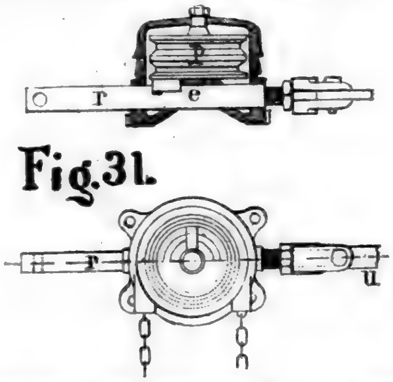


Fig. 31.

unless the signals have been put in the proper position; and as these are locked electrically from the central signal station, it follows that the station-master indirectly controls the position of all the switches. This arrangement,

slot is not opposite the lug, and the pulley is fixed; the signal which remains at *Stop* can then be changed. If the switch has two positions (that is, if it is what we call a three-throw switch) it is sufficient to make two slots in the bar *r*, and then the signal is only locked at *Stop* when the switch rails are in the proper position.

We will not compare this rudimentary method of locking with the improved arrangements which we have already described, but will pass at once to the description of the interlocking between the levers. To understand this arrangement, it is necessary to show a plan of the ordinary interlocking of the block system, as in figs. 32, 33, and 34.

The semaphore being in its normal position of stop, its lever *H* is interlocked by a lug *u*, which bears against the extremity of the counterweighted lever *r*. To unlock it, and throw the lever *H* up in such a way as to lock the semaphore, it is necessary to work an indicator and to cause alternate currents to pass through the electro-magnet *T*; the armature then oscillates, and its extremity *S* releases successively the teeth of the sector *J*, which besides its use for showing alternately the red and black, is also used to unlock the signal; for this purpose its shaft *x* is hollow, but when the signal falls under the action in the oscillations of *S* the hollow of this axle *x* permits the lever *a* to escape; the end of this lever *c* is connected with the

Fig. 32.

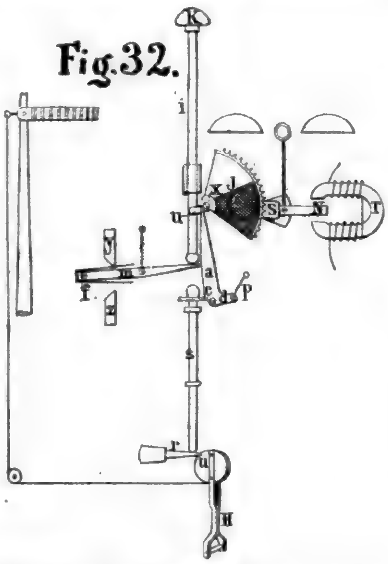


Fig. 33.

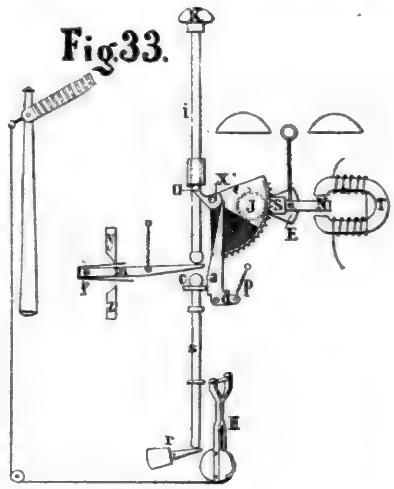
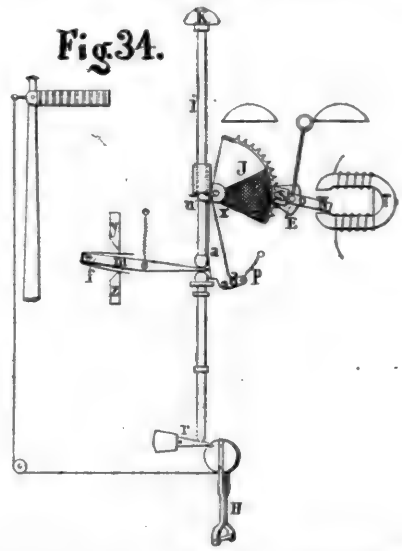


Fig. 34.



prescribed by the regulations of the German railroads, has been made with the intention of placing on one person the concentrated responsibility for the movement of the signal, while keeping others specially employed to work the switches. We will not find, then, in the description of this system, combinations springing from the necessity of concentrating in a single signal cabin a great number of apparatus for the purpose of effecting various movements; but as the Siemens apparatus has as yet never been fully described, it will be of interest to give an account of an installation made under these conditions. The station which we take as an illustration is that of Callau, on the line from Berlin to Gorlitz.

Figs. 29 and 30 show the apparatus in the signal cabin; the levers are all of a type very similar to that which we have just described, under the Froitzheim system; to give them a movement of 180 degrees, in raising them from below to a vertical position, we must turn the pulley *Q* and give the wire *K* a movement which lowers or raises the wing of the semaphores, through which the signal is given to the engineers.

These signals can only be changed when the corresponding switches are in their proper positions for the passage of trains; for that purpose, on the line of transmission of the signal, there is placed a locking-bolt for the switch, as shown in fig. 30.

On the inside of a cast-iron case is a pulley *p*, which can turn around on a vertical axis, and is furnished below with a small lug *e*. When the switch is in proper position this lug fits into a slot made on the bar *r*, depending from *w* to the switch rail. When the switch rails are not fully in contact, or when the position of the switch is changed, this

piston-rod *s*; this is drawn down by the counterweight of the lever *r*, and can then raise itself, the apparatus taking the position shown in fig. 32; the lever *H* is then set free and the semaphore can be changed.

Fig. 35.

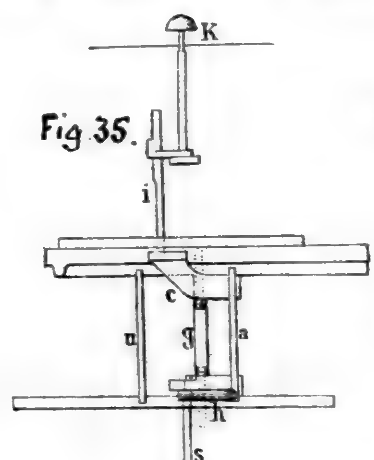
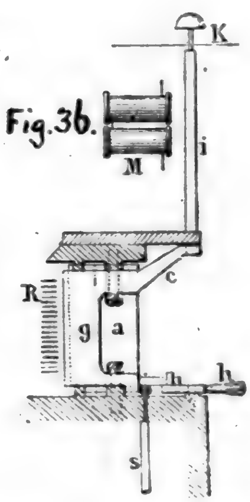


Fig. 36.



When the signal has been put back at *Stop*, it is again locked by pressing on the button *K*, which causes the lever *r* to descend into the slot *u*.

If now we look back at figs. 29 and 30 we will see that each signal lever *H* has corresponding to it a handle *h*, which the signalman can use from left to right and *vice*

versa. Figs. 35, 36, and 37 show how these handles are in connection with the buttons *K* and the rods *s*.

Each of these handles, as shown in fig. 37, works a lever with three arms *g*; the branch *z* moves horizontally toward the right or left one of the bars *R*. The branch *y* causes the lugs *n* to enter into slots made on the bars depending from other signals; from this it follows that the handles *h* are interlocked with each other; the lever *g*

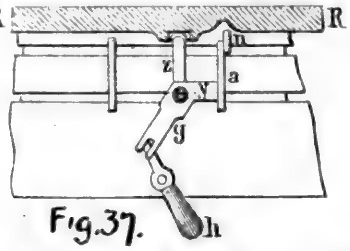


Fig. 37.

acts on a rod *s*, which commands the counterweighted lever *r*, which is similar to that used to lock or unlock the direct movement of the signals. When the handle *h* is passed from left to right it causes the rod *s* to descend and to lock the lever of the signal by means of an inclined plane situated on the lower end of the lever *g*. Inversely, when the signal is at *Line Clear* as the rod *s* is relieved by the counterweight *r*, it is impossible to move the handle from left to right.

Finally the lever *g*, figs. 35 and 36, carries a third arm *c* furnished with a hollow in which the rod *i* of the button *K* can enter, when the bottom is pressed, but this movement can be made only if the handle *h* occupies its normal position to the left.

It will be seen from this brief description that this apparatus only permits binary and simple interlockings, and that it could not be used for the varied combinations required by the concentration of a great number of levers, as is the rule in French stations. We can characterize exactly enough the great difference between this system of movement and that to which we are accustomed in France by saying that, on the one hand, we seek the decentralization of responsibility and the concentration of apparatus, while, on the other hand, the intention is to centralize the authority in the hand of the station-master while avoiding concentration of the apparatus. It is possible that this last method may not be as well fitted as the other for the quick operations demanded by a large traffic and a constant movement of trains.

(TO BE CONTINUED.)

LIQUID FUEL ON LOCOMOTIVES.

(From the London *Engineering*.)

In view of the rapid development which is taking place in the various branches of the petroleum industries, and the transport facilities which are being afforded by the building of tank steamers, etc., very considerable interest attaches to the mode of employing liquid fuel on locomotives now being carried out by Mr. James Holden, the Locomotive Superintendent of the Great Eastern Railway. That locomotives can be worked—and most successfully worked—by the use of liquid fuel alone has been amply demonstrated by the experience of Mr. Thomas Urquhart, on the Grazi-Tsaritsin Railway in South Russia, and by the experiments on the Pennsylvania Railroad, where Mr. Urquhart's system has been thoroughly tested. But the conditions existing in South Russia are eminently different to those existing in this country, and in the present state of our liquid fuel supply, and the irregularities in the market which—probably for some little time to come—would be produced by any abnormal demand, grave difficulties exist in the employment of such fuel on any English railroad in the exclusive manner in which it is so successfully used by Mr. Urquhart.

These and other practical difficulties have been thoroughly appreciated by Mr. Holden, who has met them in a thoroughly common-sense way. In place of altering any of his engines to use liquid fuel burners exclusively, he has been contented—for the present, at all events—to use the liquid fuel as an auxiliary to, and not as an entire substitute for coal, and while making provision for replacing a large proportion of coal by liquid fuel, he has left the engines fitted with his apparatus fully available at any moment to work with coal alone if desired. In fact, the change from using coal and liquid fuel in combination to coal alone can be—and has been—made in the middle of a run without inconvenience.

The arrangements which Mr. Holden has devised for burning the liquid fuel are very simple, and will be readily understood from the annexed engravings. From these it will be seen that the ordinary fire-grate and fire-brick arch are left unaltered, the only alteration in the fire-box being the insertion of a couple of tubes about 6 in. in diameter through the rear water-space, one on each side below the level of the fire-door, as shown in figs. 1 and 2. To each of these tubes is fitted a liquid fuel injector combined with a ring-jet for inducing a current of air. A perspective view of one of Mr. Holden's injectors is given in fig. 3, while fig. 4 is a section. The best proportions for these injectors and the best disposition of the accompanying ring-jet have, of course, been arrived at after a considerable amount of experimenting, but the arrangement itself is extremely simple and answers its purpose admirably. The steam is supplied to the central jet of the injector, on

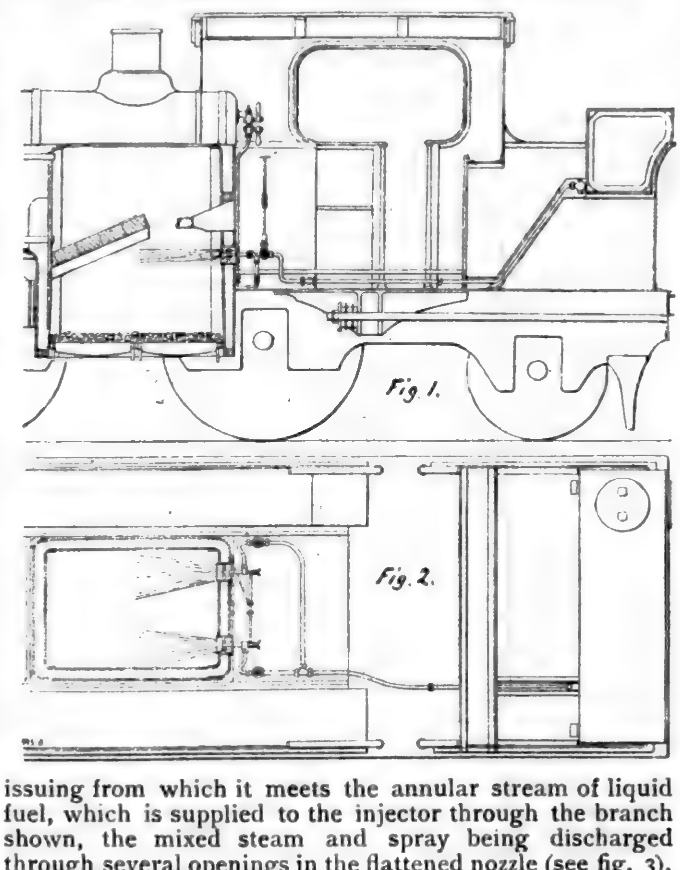


Fig. 1.

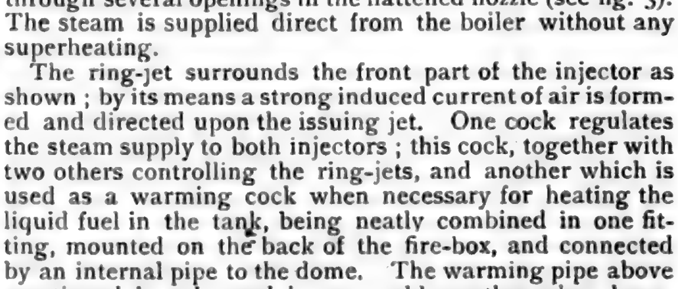


Fig. 2.

issuing from which it meets the annular stream of liquid fuel, which is supplied to the injector through the branch shown, the mixed steam and spray being discharged through several openings in the flattened nozzle (see fig. 3). The steam is supplied direct from the boiler without any superheating.

The ring-jet surrounds the front part of the injector as shown; by its means a strong induced current of air is formed and directed upon the issuing jet. One cock regulates the steam supply to both injectors; this cock, together with two others controlling the ring-jets, and another which is used as a warming cock when necessary for heating the liquid fuel in the tank, being neatly combined in one fitting, mounted on the back of the fire-box, and connected by an internal pipe to the dome. The warming pipe above mentioned is only used in very cold weather when burning tar or very heavy oils. The liquid fuel flows to the injectors by gravity, the tank containing it being sufficiently elevated; the supply is regulated by a separate cock to each injector. Provision is also made for blowing steam through all the oil pipes, etc., and, in fact, the whole of the arrangements are worked out in a thoroughly practical way.

In working on Mr. Holden's system a thin coal fire is kept on the grate, and to assist in keeping the grate properly covered with a very thin fire, lumps of chalk are placed on the grate when starting work for the day. The ash-pan dampers are kept very nearly closed, nearly the whole of the air required for supporting combustion entering either

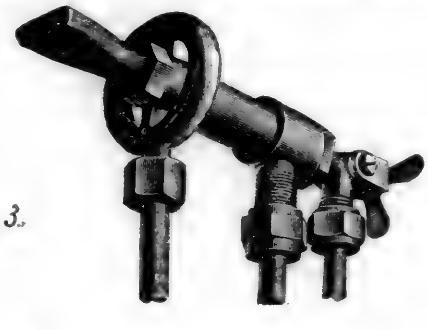


Fig. 3.

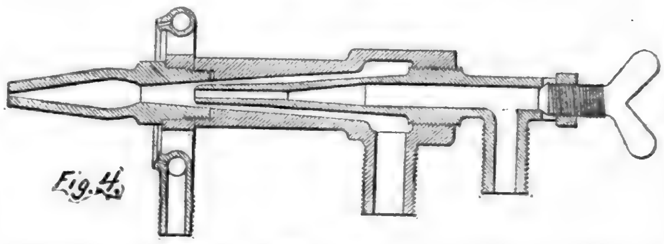


Fig. 4.

through the injector tubes or at the fire-door, which is kept open and fitted with an internal deflector just as when coal alone is being burned. It is found that when burning the liquid fuel an exceedingly soft blast is required, and the blast nozzle has to be materially larger than usual. Thus in the case of engine No. 193, of which we shall speak presently, and which has cylinders 17 in. in diameter by 24-in. stroke, the blast nozzle has been enlarged to 6 in. in diameter, while the smoke-box has also been fitted with air valves, by which air can be admitted near the base of the chimney and the exhaustion due to the blast thus diminished. To enable the engine to be used as a coal-burner, if necessary, however, the blast pipe is fitted with a supplementary nozzle of the ordinary size, which by means of an external lever can be at once brought into position.

The first experiments of Mr. Holden on liquid fuel burning were made at the Stratford Works of the Great Eastern Railway Company on a boiler in the department where Pintsch's oil gas is manufactured for lighting trains. At these gas works one of the products is a tar which it is difficult to dispose of at any price, but this is now burned under the boiler, which was fitted with the liquid fuel apparatus early in 1886. The boiler is a small one of the Cornish multitubular type, 10 ft. long by 4 ft. in diameter, with a furnace 7 ft. long by 3 ft. in diameter, from which 122 iron tubes 1¾ in. in diameter by 3 ft. long extend to the back of the boiler. The boiler is worked at 60 lbs. pressure, and when coal was used the consumption per week (79 hours in steam) averaged 68 cwt. 1 qr. 16 lbs., or 97.1 lbs. per hour. With the liquid fuel apparatus the consumption per week, with 69 hours in steam, has averaged 454⅓ gallons of tar and 2 cwt. of coal, or an average per hour of 65.9 lbs. of tar and 3.4 lbs. of coal.

The arrangement was next applied to three boilers of the locomotive type in the wagon department at Stratford, and on these its performance has been very satisfactory. The boilers are worked at 80 lbs. pressure, and the comparative results of a week's working with coal only and with coal and liquid fuel in combination have been as follows :

With coal (Staveley) only, the consumption for 63½ hours' work, including lighting up, was 156 cwt., or 275.1 lbs. per hour. With the coal and oil in combination there were used in 60½ hours' work (including lighting up) 55 cwt. of Staveley coal and 546 gallons of green oil, or an average of 101.8 lbs. of coal and 99.3 lbs. of oil (= 9 gallons) per hour. With coal only the evaporation was at the rate of 7.16 lbs. of water per pound of coal, while with the coal and oil it was 8.91 lbs. per pound of the combined fuels.

Subsequently the system was applied to a furnace in the steam hammer shop, a rivet furnace in the boiler shop, a Cornish boiler in the printing department, a six-coupled tank locomotive used for shunting purposes, and a four-coupled tank passenger locomotive (No. 193).

In the case of the printing-office boiler just mentioned the apparatus is fitted as shown in fig. 5 annexed, and a comparison of the cost of working with coal only in 1887, and with coal and liquid fuel during the present year (the comparison being made for a week in each case), gives the following results :

Coal only Used.—1887. Consumption during one week from August 15 to 20 (inclusive), 74½ hours' work, including lighting up = 80½ cwt. = 121.3 lbs. per hour.

Cost for 100 hours = 12,130 lbs. of coal at $2.64 per ton = $14.31.

Coal, Coke, and Tar—" Holden's System."—1888. Consumption during one week from June 25 to 30 (inclusive), 87¾ hours' working, including lighting up

= coal 15 cwt. = 19.2 lbs. per hour.
= coke 11½ " = 14.7 " "
Gas tar 280 galls. = 35.1 " "

Total......... 69 lbs. per hour.

Cost for 100 hours
= 1,920 lbs. of coal at $2.64 per ton = $2.27.
= 1,470 " " " 2.28 " = 1.47.
= 3,510 " " " 3.00 " = 4.70.

Total......................... $8.44

The passenger tank locomotive No. 193, which we have mentioned above as being fitted with the liquid fuel apparatus, has, as we have already stated, cylinders 17 in. in diameter with 24-in. stroke, and coupled wheels 5 ft. 4 in. in diameter, and since it was fitted with the apparatus in March, 1887, it has been running most successfully, working heavy suburban trains of 15 carriages, making frequent stops, while it has also been employed taking main line passenger, averaging about 10 carriages, on longer runs. Through the courtesy of Mr. Holden we have had an opportunity of traveling on this engine, and we can testify to the ease with which the liquid fuel apparatus can be managed.

With the liquid fuel it is found that the steam is kept up more easily and steadily than when coal alone is used, while the liquid fuel gives especial facilities for getting up

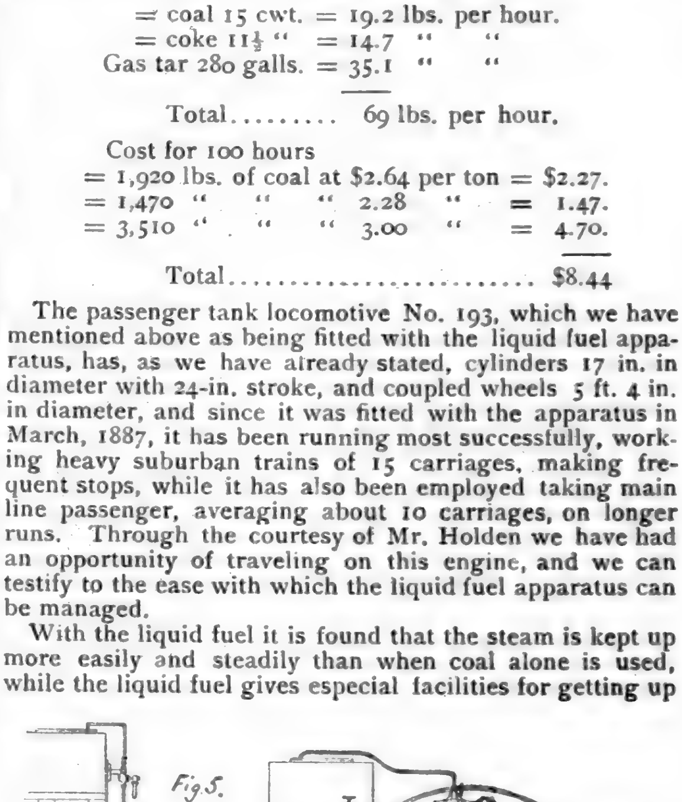


Fig. 5.

steam rapidly if required, the pressure being raised from 50 lbs. to 140 lbs. in nine minutes with the engine standing. Engine No. 193 is fitted with a liquid fuel tank containing 210 gallons, and this quantity will, as a rule, last for a run of about 200 miles, varying of course according to the weight and character of the train hauled. Various kinds of liquid fuel have been used, and the apparatus appears capable of dealing with any of the ordinary marketable qualities. On the occasion of our making a trip on the engine there was being burned a mixture of one-third "green" oil with two-thirds tar, and this was burned entirely without smoke or trouble of any kind. Roughly speaking, the consumption of fuel on the engine above referred to is one gallon (or 11 lbs.) of liquid fuel (a mixture of two-thirds ordinary gas tar and one-third creosote or

furnace oil) to about 14 lbs. of coal per mile. We subjoin particulars of a comparative trial of this engine and a sister engine, No. 194, employed in working the same trains, No. 193 burning coal and liquid fuel in combination, and No. 194 coal only. Radford coal was used in both cases. The trial commenced July 12, and concluded July 20, 1888, each engine having worked six days. The following statement shows miles run, quantity and cost of fuel, etc., consumed by each engine during that period :

Engine.	Miles run.	Fuel used, pounds.				Cost.
		Coal.	Liquid fuel.	Chalk.	Total.	
193	951¾	13,511	10,505	784	24,800	$33.99
194	951¾	27,738	......	...	27,738	44.33

Results per Mile.

	Fuel used, pounds.				Cost.	Per cent. of liquid fuel and chalk to coal used.
	Coal.	Liquid fuel.	Chalk.	Total.		
193	14.2	11.0	0.8	26.0	3.58 cts.	83 per cent.
194	29.1	....	...	29.1	4.65 "	....

Cost of coal, per ton (2,240 lbs.), $3.58 ; liquid fuel, per gallon (11 lbs.), $1.25 ; chalk, per ton, $1.32.

It will be seen from the facts we have stated above, that Mr. Holden's system of using liquid fuel is one of very great promise, and it appears to us of especial value for use in cases where it is of importance to be able to at once revert to burning coal alone, as may occur in consequence of fluctuations in the market price of oil or other circumstances. In the case of railroads, for instance, it is an especial convenience that an engine fitted up for burning liquid fuel can at any time be run with coal alone in the event of its having to work in a district where a store of liquid fuel has not been established. In the case of war-vessels also the use of liquid fuel as an addition to coal appears to have many practical advantages not at present attendant on the use of liquid fuel alone. We believe it is intended to extend the application of the system on the Great Eastern Railway, and we hope in due course to be able to place before our readers a further account of the results obtained.

NOTES ON STEAM HAMMERS.

BY C. CHOMIENNE, ENGINEER.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 550.)

CHAPTER XXVI.

THE FIVES-LILLE DOUBLE-ACTING HAMMER.

FIGS. 90, 91, and 92 show a small double-acting hammer made by the Fives-Lille Company, for drawing out and for ordinary shop forgings.

This hammer is of a very simple design, and its parts are few ; steam is admitted to the steam-chest by a flat horizontal valve, and the distribution is made by a circular balanced valve. The levers by which both are operated are close to the hand of the hammerman.

The piston, which is shown in fig. 90 in the cover of the cylinder, takes the place of the arm usually placed on the axis of the working lever to limit the stroke of the piston. This arm was worked by the movement of the lower part of the piston-rod, and it was found that one inconvenience of the arrangement was that it was apt to give the hammerman a pretty forcible blow if he allowed the piston to move too long.

Steam acts upon the upper surface of this additional piston, being carried there through a pipe which is connected with the steam pipe of the hammer. When the piston is allowed to rise too high it closes the steam port in the upper end of the cylinder, and there is then a cushion of compressed steam between its upper face and the lower face of the additional or safety piston, and consequently the latter receives a slight movement upward, which in its turn is limited by the compression of the steam between its upper surface and the cylinder head, the small valve of the latter being closed by the first movement of the safety piston ; an equilibrium is very quickly established between these two pressures, and the upward movement of the hammer is thus arrested without shock.

This hammer is not automatic ; it is worked by hand, and with full stroke can give about 60 blows a minute. If, on the other hand, a shorter stroke is used, giving a light blow, it can be run up as high as 120 to 150 blows per minute.

The piston-rod has two flat surfaces made one on each side, which, with the long stuffing-boxes used, secures perfect guidance, and prevents the hammer-head from turning.

Four sizes of this type of hammer are made by the Fives-Lille Company, the dimensions being as follows :

	Diameter of piston.	Stroke.	Weight of striking mass.
1.	0.280 meter.	0.535 meter.	300 kilos.
2.	0.330 meter.	0.600 meter.	450 kilos.
3.	0.360 meter.	0.700 meter.	590 kilos.
4.	0.400 meter.	0.850 meter.	980 kilos.

In all these hammers the base of the frame has a large surface, giving the tool the greatest stability possible.

CHAPTER XXVII.

THE MULHOUSE DOUBLE-ACTING HAMMER.

Figs. 93, 94, and 95 show a small double-acting hammer built by the Société Alsacienne at Mulhouse, fig. 93 being a front view, fig. 94 a section, and fig. 95 a plan. The diameter of the steam cylinder is 0.300 meter, and the maximum stroke of the piston is 0.850 meter.

The admission of steam into the steam-chest is given by a valve worked by a lever placed conveniently to the hammerman. The distribution of steam is through a circular balanced valve, consisting of two pistons of bronze, which work in a cylinder, also of bronze, furnished with openings for the admission and exhaust of steam. These pistons have no packing ; they are loose and work easily in the cylinder.

If the hammer arrives near the upper end of its stroke before steam has acted on the upper part of the piston to cause it to descend, it strikes a lever connecting with the valve-rod, thus throwing up the lever and admitting steam at once to the upper end of the cylinder.

The water of condensation is carried off by a small pipe which is connected with the bottom of the steam-chest, and which carries off this water to the ground.

The piston is of iron, and is forged in one piece with the rod ; it is provided with three packing rings of steel. The piston-rod is of circular section, and as in the hammer described above, there are two flat surfaces made on it, as shown in figs. 94 and 95, which prevent it from turning, and which also serve in connection with the stuffing-box as guides. The lower part of the piston is slightly conical and enters the hammer-block, which is simply shrunk on, no further attachment being found necessary.

The hammer is of wrought iron, its face being hardened and tempered. The anvil is made in the same way, and is fixed by a dovetail to a block of cast steel, which rests upon a large base in the foundation.

The total weight of this tool is about 10 tons. The base rests on a separate foundation upon a bed of oak timbers, held together by bolts. This bed in its turn is placed on a mass of beton or concrete, the thickness and size of which vary according to the nature of the soil.

This hammer works by hand, and is not automatic. It is very convenient for forging pieces of moderate dimensions, as, for instance, the material used in the construction of locomotives. The force of the blow can be regulated at will according to the effect which it is desired to produce.

A small hammer of this or a similar class is now almost indispensable in a machine shop of any size.

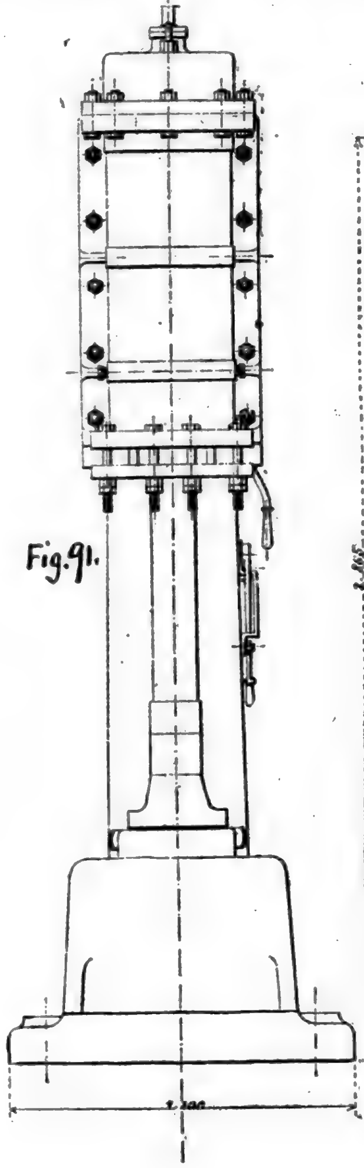
CHAPTER XXVIII.

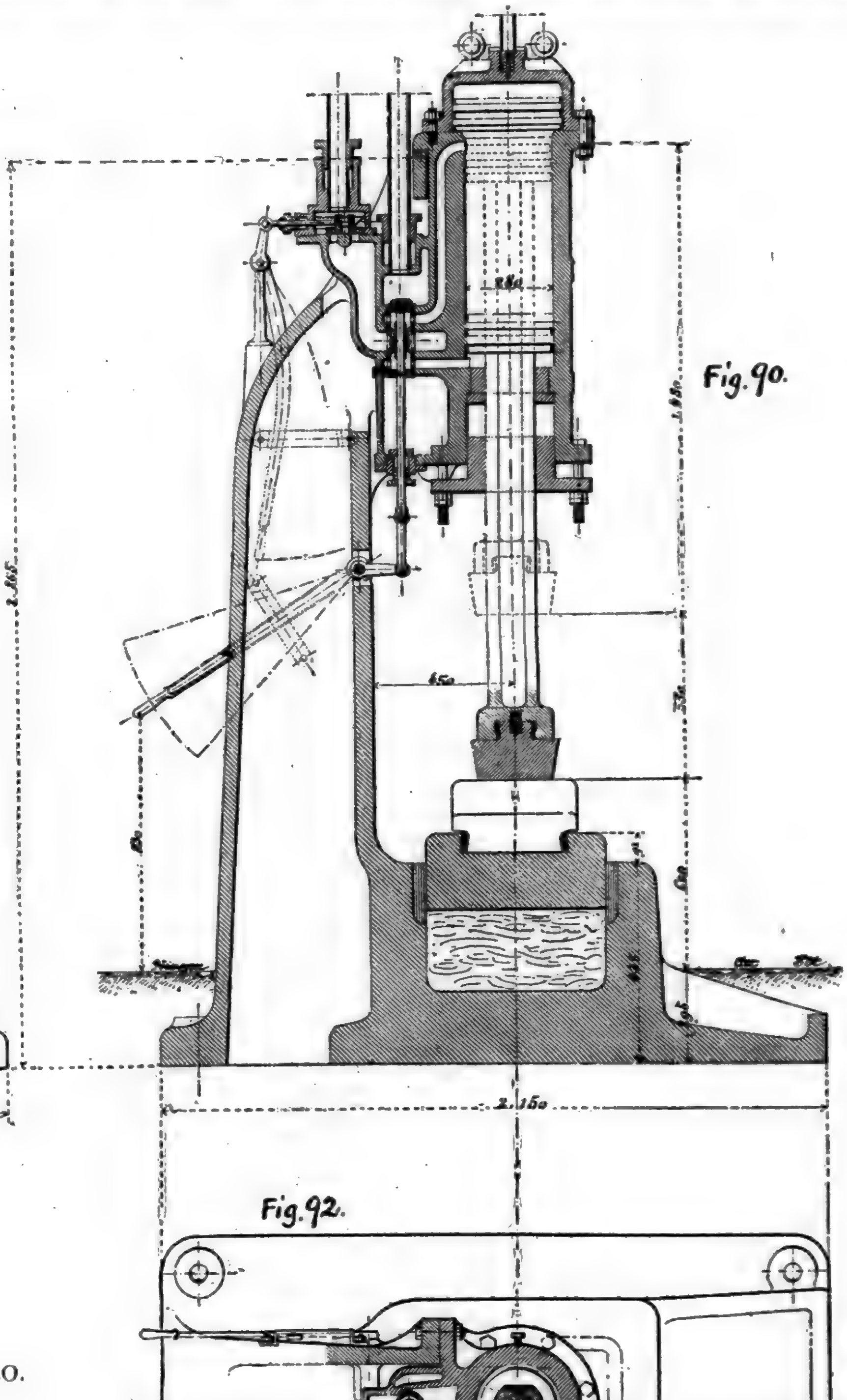
BEMENT, MILES & COMPANY'S DOUBLE-ACTING HAMMER.

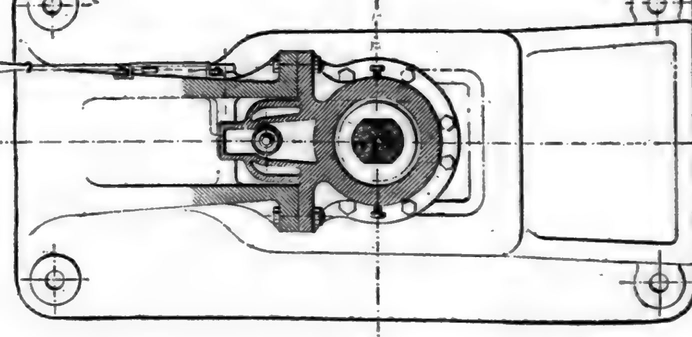
Figs. 96, 97, 98, and 99 show a double-acting hammer built by Bement, Miles & Company, Philadelphia, fig. 96 being an elevation, fig. 97 a front view, and fig. 98 a plan,

cast iron, which moves in a brass sleeve or bushing, having steam and exhaust ports.

This hammer can work automatically or by hand; the automatic movement is obtained by a lever with two arms, one of which by means of a bell-crank works the valve-rod, while the other receives its movement through an inclined







THE FIVES-LILLE 300-KILO. HAMMER.

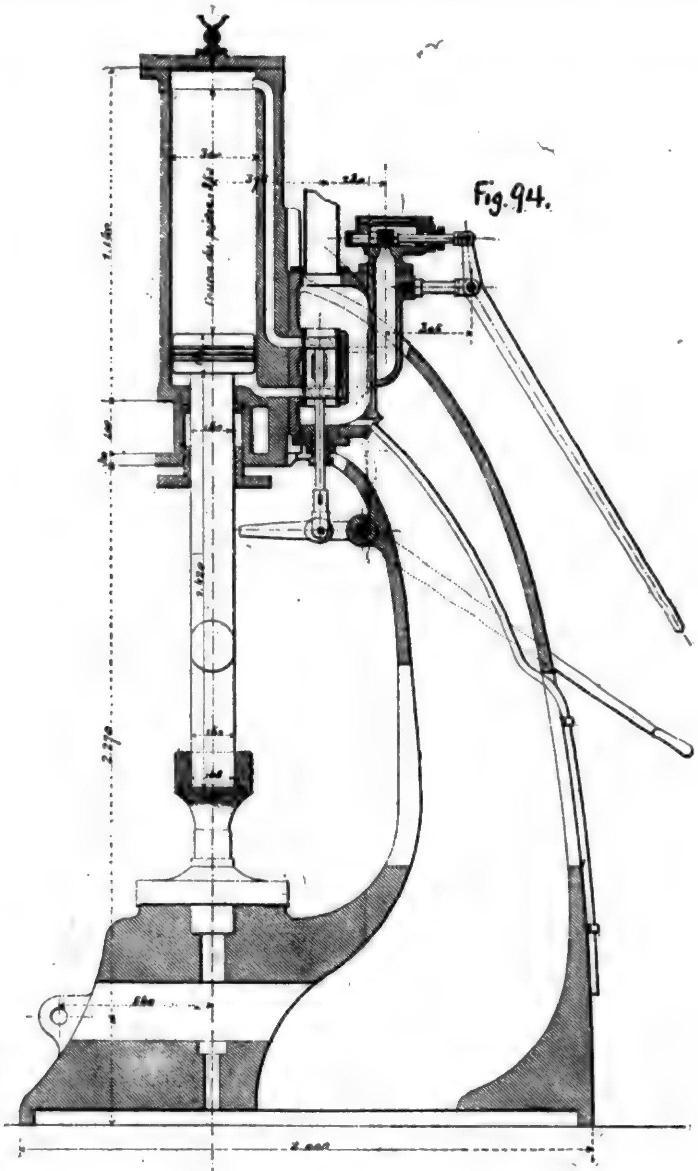
It approaches somewhat in general form and arrangements to the Massey hammer. The diameter of the steam cylinder is 200 mm., and the maximum stroke of piston is 560 mm.

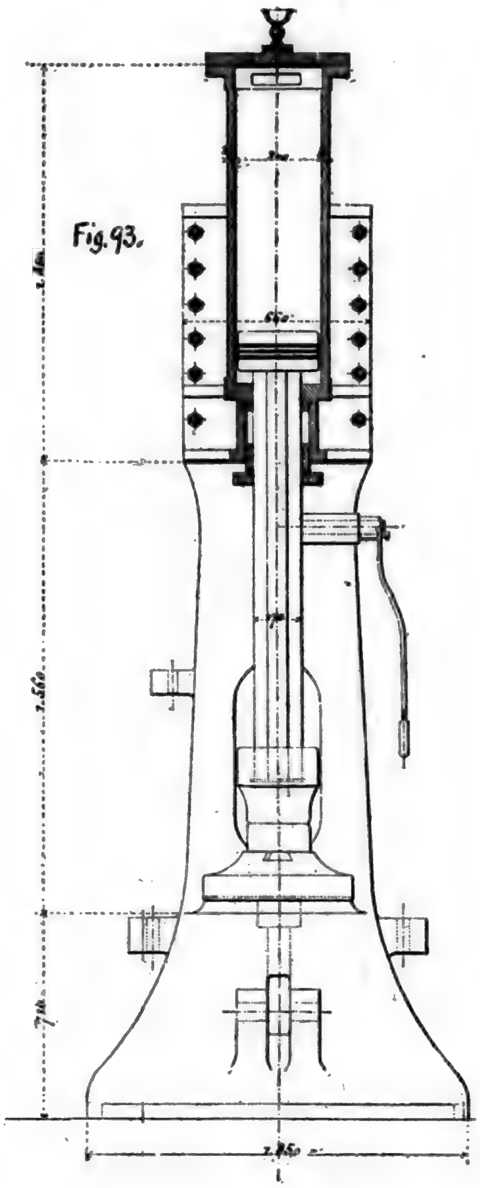
Steam reaches the steam-chest through a throttle-valve worked through a lever by the hammerman, and the distribution of steam is made by a circular balanced valve of

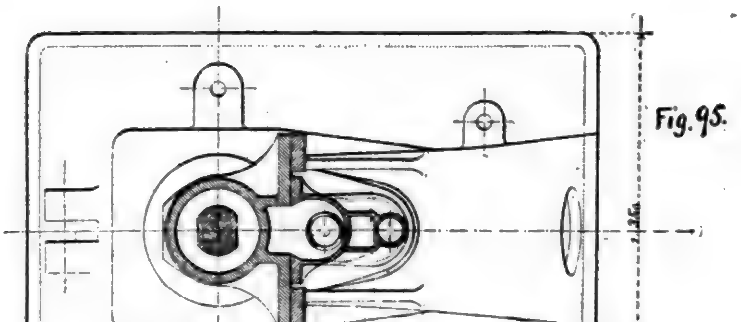
plane made on the back face of the hammer, in order not to disturb the hammerman. This inclined plane is formed of a bar of steel which can be changed at will. If it is desired to work the hammer by hand, all that is necessary is to detach this bar. Above the cylinder and on the center line of the hammer are two springs, the object of which is to take up the shock in case the piston should be allowed

to rise too high. These springs are shown on a larger scale in fig. 99.

The hammer is either of wrought iron or of steel. Its center line is at an angle with that of the frame, in order to give more room for drawing out or forging. The hammer is guided by cast-iron V-shaped slides, which are fastened to the frame by bolts in such a way that they can be







THE MULHOUSE 300-KILO. HAMMER.

replaced at will. These slides carry on each side keys by which the wear can be taken up.

The anvil-block is centered in the frame, and is fastened by four keys which prevent any rotary movement.

This hammer, which is of simple construction, is an excellent tool for forging light pieces.

CHAPTER XXIX.

THE BANNING DOUBLE-ACTING HAMMER.

Figs. 100, 101, 102, and 103 show a small double-acting hammer built by M. Banning at Hamm, in Westphalia. It consists of a frame of cast iron fixed upon the anvil-block by means of bolts and keys. The anvil-block has a circular base of considerable dimension, and carries a series of bosses provided with holes which permit the passage of spikes or bolts, which fix the base on a bed of timbers, which, in its turn, rests on a mass of masonry.

The cast-iron frame carries steel guides which direct the motion of the hammer and prevent any rotary movement.

The hammer, the piston-rod, and the piston are of steel, forged in one piece.

This hammer is especially intended to draw out iron and steel bars. The distribution of steam is made by a flat D-shaped valve. The hammer works directly one arm of a lever, the other end of which acts upon the valve-rod. The upper part of this lever is fixed eccentrically on a small shaft which can also be worked through a hand lever; consequently the stroke of the hammer can be varied according to the thickness of the piece to be forged. Steam reaches the steam-chest through a small valve which is worked by the machinist.

The diameter of the steam cylinder is 320 mm., and the maximum stroke of the hammer is 630 mm. When this type of hammer is intended to make ordinary forgings the automatic motion and the flat valve are replaced by a cir-

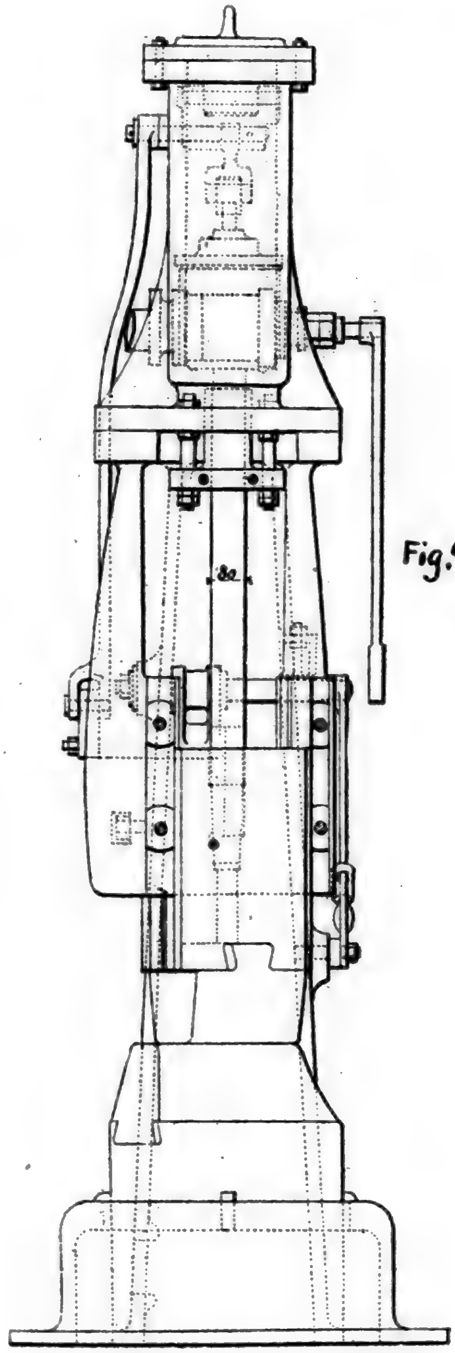


Fig. 97.

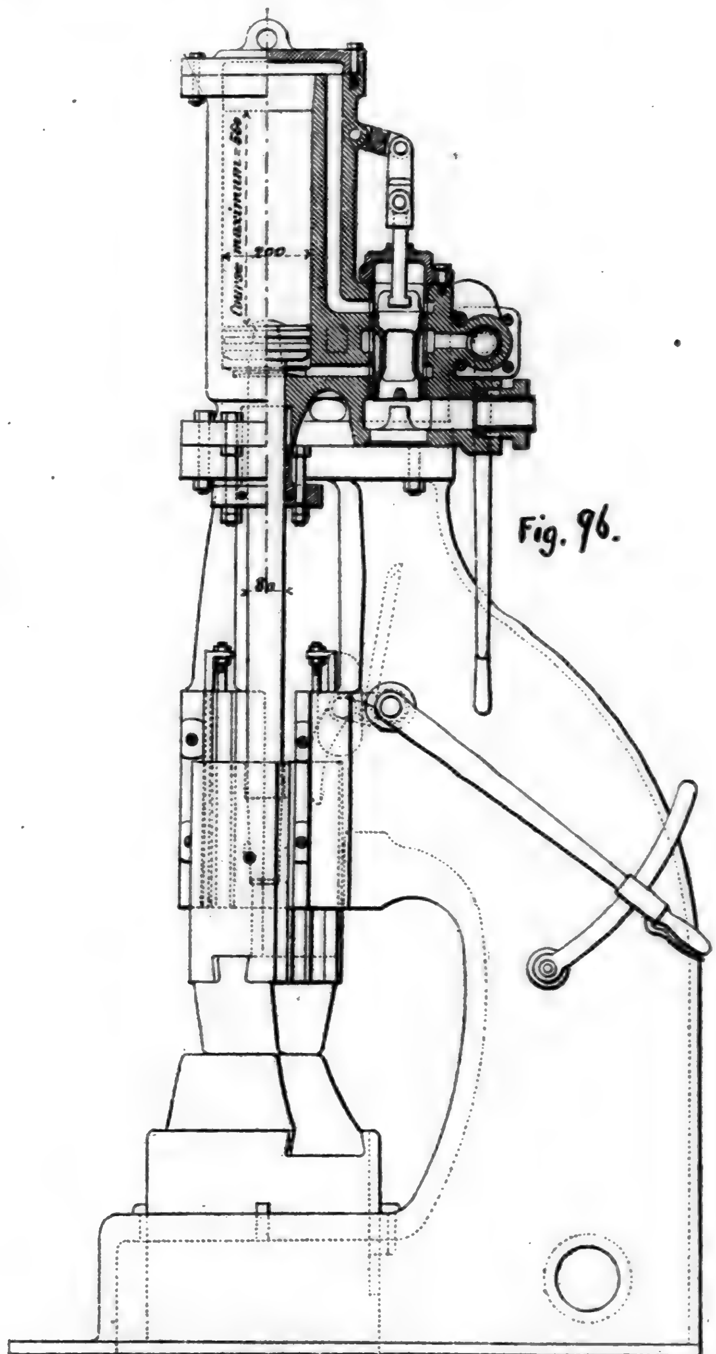


Fig. 96.

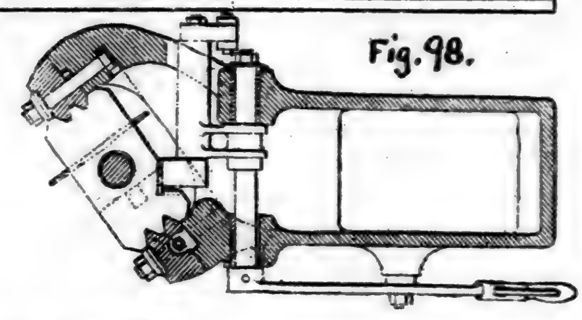


Fig. 98.

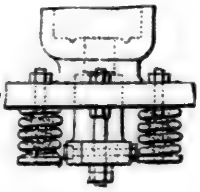


Fig. 99.

THE BEMENT 360-KILO. HAMMER.

cular balanced valve, and the hammer is worked by hand.

This type of hammer, which has a force varying from 50 to 1,000 kilos., is always double-acting, and in most cases is worked automatically and at high speed.

chest through a valve which can be opened or closed at will by the hammerman, and the distribution is made through a circular balanced valve. The two levers are so placed that they can be readily worked by the hammerman, and the small escape valve intended to relieve the

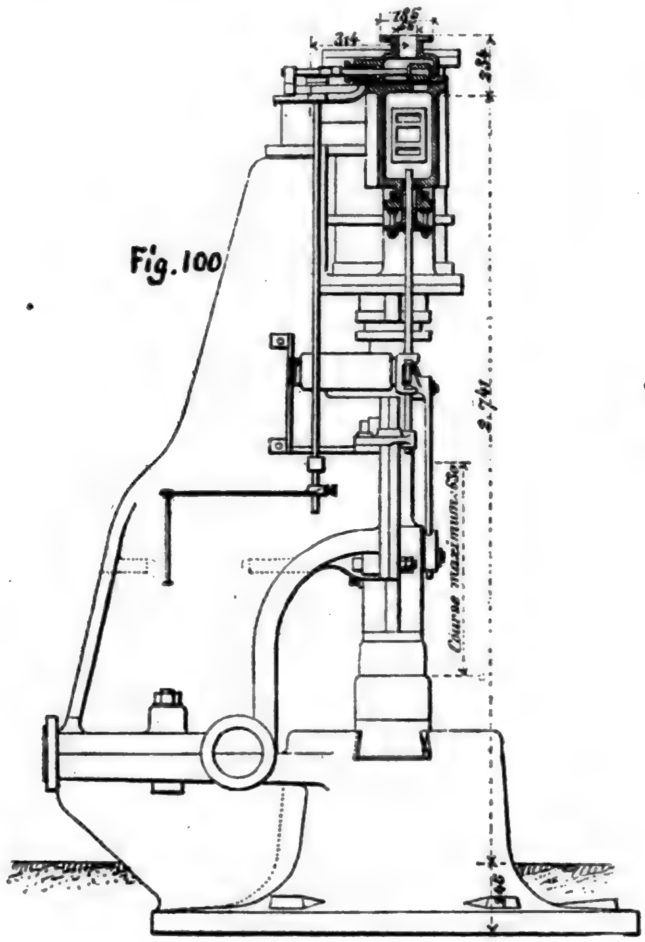


Fig. 100

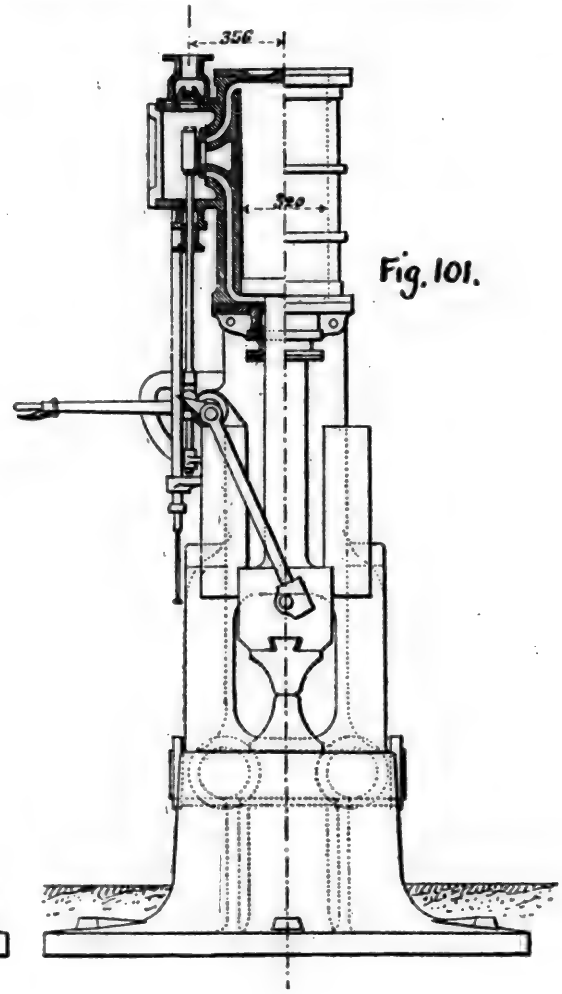


Fig. 101.

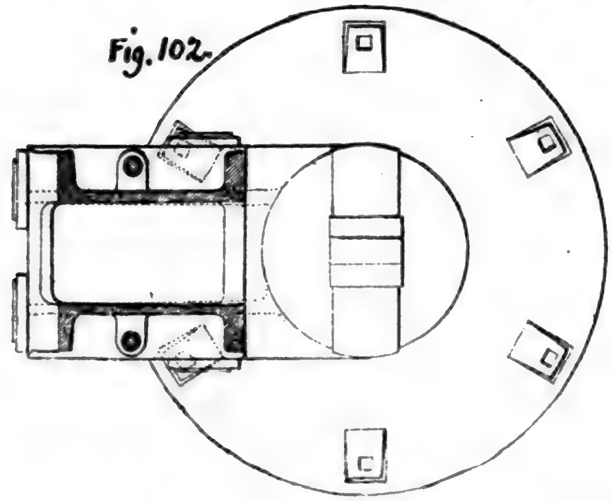


Fig. 102.

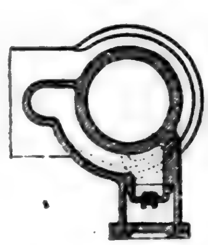


Fig. 103.

THE BANNING 400-KILO. HAMMER.

CHAPTER XXX.

THE THWAITES DOUBLE-ACTING HAMMER.

This hammer, shown in figs. 104 and 105, has an independent anvil-block, and its foundations are made with much care. The lower part of the piston-rod carries an arm which works a lever, thus rendering the hammer automatic. If it is preferred to work the hammer by hand, it is sufficient to detach this arm. Steam reaches the steam-cylinder from the water of condensation is also so placed that he can readily reach it.

The diameter of the piston is 355 mm., and its stroke 676 mm. The weight of the striking parts is 600 kilos.

The shaft on which the valve lever works carries at one end an arm which is put in motion by the lower part of the piston-rod, thus serving to limit the stroke.

(TO BE CONTINUED.)

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(*Continued from page* 566.)

CHAPTER XXI. (*Continued.*)

COMBUSTION.

Question 556. *How can the process of the combustion of the gas generated from the coal be best explained?*

Answer. As this gas is substantially the same as ordinary illuminating gas, the manner in which it burns can, perhaps, be made clearer by examining the combustion of an ordinary gas-light. As stated before, combustion is a chemical union of the oxygen which forms one of the elements of the air with the hydrogen and carbon of the fuel, which, in this case, form gas. It should be clearly kept in mind that combustion is the result of this union, and that the oxygen is as essential to combustion as coal or gas, and, in fact, is the fuel of combustion just as much as coal or gas is. If we were to conduct a pipe from the external air into a vessel filled with coal gas we could *light the air* and it would burn in the gas as the gas burns in the air.

It will be noticed, however, that before either the gas or the air will burn, they must be lighted. Air and gas, even if mixed together in the same vessel, will not burn unless they are lighted. This can be done by the flame of any burning material, or with a piece of metal heated to a very high temperature, or by an electric spark. In other words it may be said that the atoms of the two gases must be excited into activity by the application of heat, that is, what is called an *igniting temperature* must be communicated to them before chemical combination will begin. The chief feature which distinguishes combustion from other chemical union is the circumstance that the heat generated during the combination is sufficient to maintain an igniting temperature, and the necessity of doing so in order to continue the process is of very great importance in the combustion of coal in locomotive boilers, as will be shown hereafter.

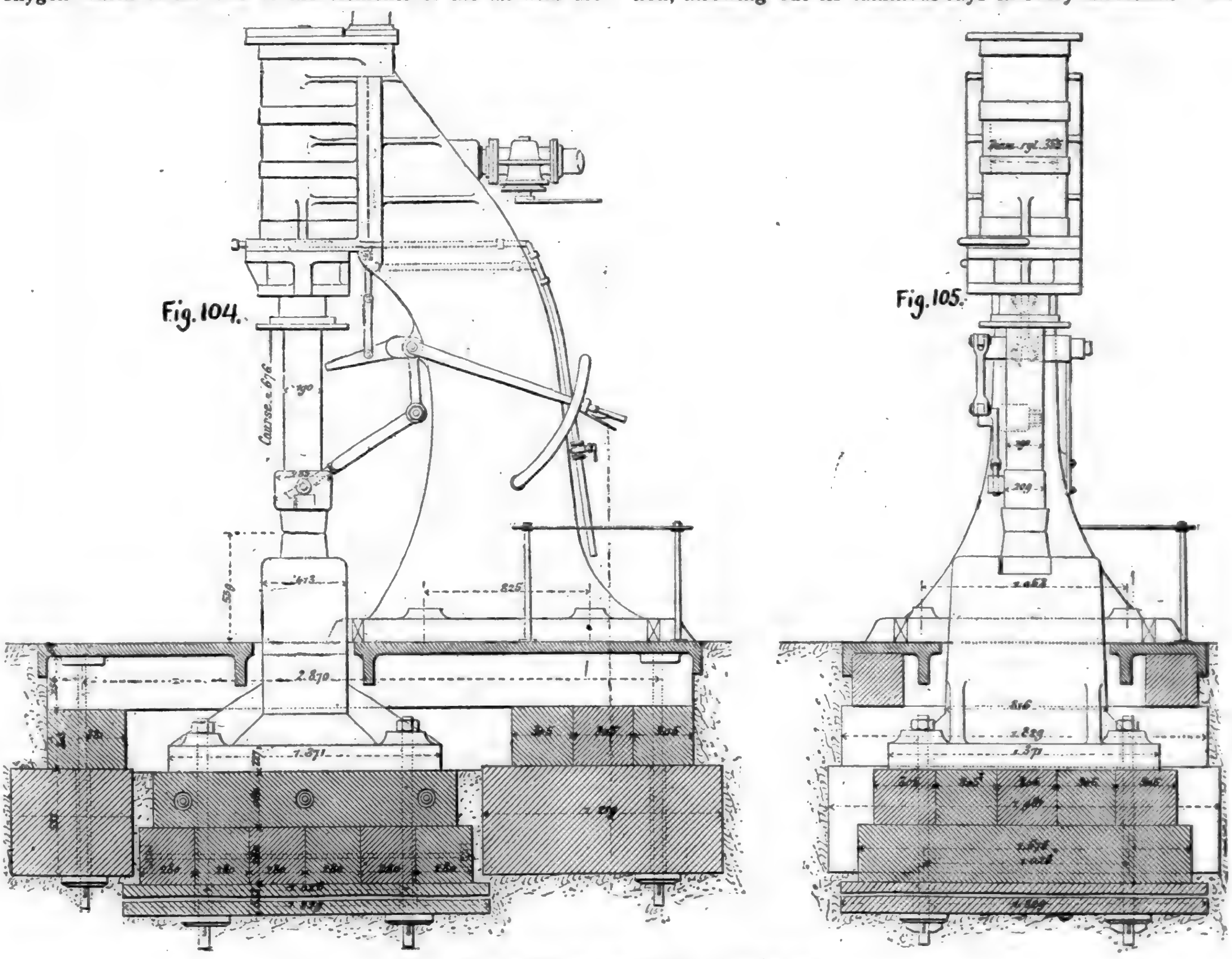
Question 557. *How does an ordinary gas-light burn after it is lighted?*

Answer. Under ordinary conditions the hydrogen, which is the most combustible of the two elements of which coal gas is formed, is the first to burn. This part of the combustion forms the lower bluish part of the flame. The combustion of the hydrogen thus separates it from the carbon, which is then set free; and as carbon is never found in a gaseous condition when uncombined with other substances, it at once assumes the form of fine soot when the hydrogen is burned away from it. This fine soot, or pulverized carbon, is, however, intensely heated by the combustion of the hydrogen. Now carbon when heated to an igniting temperature will, if brought into contact with a sufficient quantity of oxygen, combine with it or be burned. Each particle of carbon thus becomes a glowing centre of radiation, throwing out its luminous rays in every direction. The sparks last, however, but an instant, for the next moment they are consumed by the oxygen which is aroused to full activity by the heat, and only a transparent gas rises from the flame. But the same process continues; other particles succeed, which become heated and ignited in their turn, and it is to this combustion of the solid particles of carbon that the light which is given out by a gas-burner or candle is due.*

Question 558. *Why does a gas-burner, candle or other flame sometimes smoke?*

Answer. Because the supply of oxygen is then insufficient to consume the particles of solid carbon which are set free and which then assume the form of soot. This can be illustrated if we cut a hole in a card, *d d*, fig. 336, so as to fit over an ordinary gas-burner *b*. If we then light the gas and place a glass chimney, *a a*, over the burner and let it rest on the card, it will be

* "The New Chemistry," by J. P. Cooke, Jr.



THE THWAITES 600-KILO. HAMMER.

found that the flame will at once begin to smoke, because very little air can then come in contact with the flame, and therefore when the fine particles of carbon are set free by the combustion of the hydrogen, instead of being burned, as they would be if the air with its supply of oxygen were not excluded from the flame by the chimney, they escape unconsumed in the form of fine black powder or soot. If we raise the chimney up from the card, as shown in fig. 337, so as to leave enough space between them at the bottom of the chimney to permit air to enter so as to supply the flame with oxygen, the smoke will instantly cease

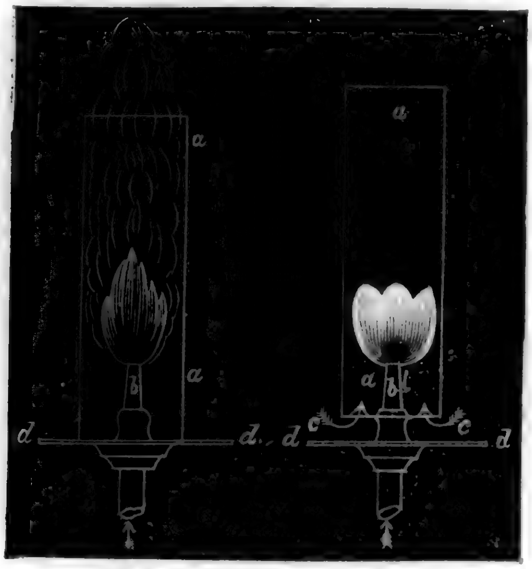


Fig. 336. Fig. 337.

as the particles of carbon are then consumed. The same principle is illustrated in an ordinary kerosene lamp. It is well known that without a chimney the flames of nearly all such lamps smoke intolerably, whereas with a glass chimney and the peculiarly formed deflector which surrounds the wick the light burns without smoke unless the wick is turned up high. The effect of the chimney is to produce a draft which is thrown against the flame by the deflector, and thus a sufficient supply of oxygen is furnished to consume all the particles of carbon, whereas without the draft produced by the chimney the supply of oxygen is insufficient to ignite all the carbon, which then escapes in the form of smoke or soot.

It must not, however, be hastily assumed that if the flame does not give out a bright light, therefore the combustion is not complete. As has already been stated, the light of the gas flame is due to the presence of burning particles of solid carbon, which is set free by the combustion of the hydrogen with which it is combined. After it is separated from the hydrogen it immediately assumes a solid form. If the coal gas is mixed with a sufficient quantity of air before it is burned, the oxygen in the latter will be in such intimate contact with the former that the difference of affinity of oxygen for the carbon and hydrogen does not come into play, and as there is enough oxygen for all, the carbon is burned before it is set free, and as there are then no solid particles in the flame, there is no light. This is illustrated by a "Bunsen burner," fig. 338, which is much used in chemical laboratories. It consists of a small tube or burner *a*, which is placed inside of another larger tube *b*. The latter has holes, *c*, *c*, a little below the top of the small tube. The current of gas escaping from the small tube produces what is called an *induced current* of air in the large tube. This air enters through the holes *c*, *c*, and is mixed with the gas in the tube *b*, and the mixture is burned at *d*. The flame from such a burner gives hardly any light, but the heat is intense, as is shown if a metal wire is held in it for a few seconds, as it will very soon glow with heat.

QUESTION 559. *What important difference is there in the structure of the flame of a Bunsen burner and that of an ordinary gas-burner or candle?*

Answer. The gas which escapes from the mouth *d* of the pipe *b*, fig. 338, is mixed with air, and therefore contains within itself the elements which only need to combine to produce combustion; whereas with an ordinary gas-burner or candle the air comes in contact with the flame only from the outside, or on its surface. This is shown better, perhaps, in the flame of an ordinary candle. The heat of such a flame distills a gas from the melted tallow, which is similar in nature to that which escapes from coal at a high temperature. Now by observing the candle very closely it will be seen that at the bottom, close to the wick, there is very little combustion, as the gas there first escapes from the wick and is not heated to a sufficiently high temperature to burn freely. A little above the lowermost part the flame is of a pale bluish color, which is due to the combustion of the hydrogen. Above that, where the carbon is set free, its particles glow with heat imparted by the burning hydrogen and are then consumed by uniting with the oxygen of the air. The combustion occurs only at the surface of the flame, the inside being a mass of combustible gas which cannot burn until it in turn comes in contact with the oxygen of the air. This can be proved by inserting one end of a small tube, fig. 339 (a pipe stem will do), which is open at both ends, into the flame. The combustible gas will then escape at the other end and can easily be lighted with a match.

It will be found that the flame from the Bunsen burner is much more intense than that of an ordinary candle or gas-burner. The reason of this is that combustion, as already stated, takes place through the whole mass of its flame, whereas an ordinary flame burns only at its surface. Common gas-jets are therefore arranged so that the flames will be flat, thus exposing as much surface to the air as possible, and, as explained in answer to Question 496, in describing the lamps for head-lights, their burners are usually made with a circular wick, through the centre of which a current of air circulates. This arrangement exposes a larger surface of the flame to the air, and also with the aid of a chimney furnishes an abundant supply for combustion. In stationary boilers, with long flues of a large sectional area, the flame will often extend for thirty feet, showing that while combustion is going on only at the surface of the flame, it takes a long time to complete the process. The same thing is shown if a gas-burner is made with a single round hole. The flame will then be very long and liable to smoke at the top.

QUESTION 560. *From the preceding considerations what may we infer to be necessary in order to consume coal gas perfectly?*

Answer. In the first place, that there must exist a certain degree of what chemists call "molecular activity," which is produced by heat, or what we have called the *igniting temperature.* The necessity of this is sufficiently obvious with ordinary gas-burners, as they must always be *lighted* before they will burn. Now imagine that it was required to burn gas which was issuing from a hundred jets, of every variety of size, in a violent wind storm, or gusts of wind. Obviously it would be necessary to keep a lighted torch all the time to relight those which would be blown out. The gas in a locomotive fire-box is in reality burned in a storm of wind more violent than any natural one. It is therefore necessary to be constantly ready to relight the streams of gas which the faintest breath would extinguish, or those of larger volume which have absorbed a great deal of heat and thus reduced the temperature at the time and place of their birth, when they assumed the gaseous form, as

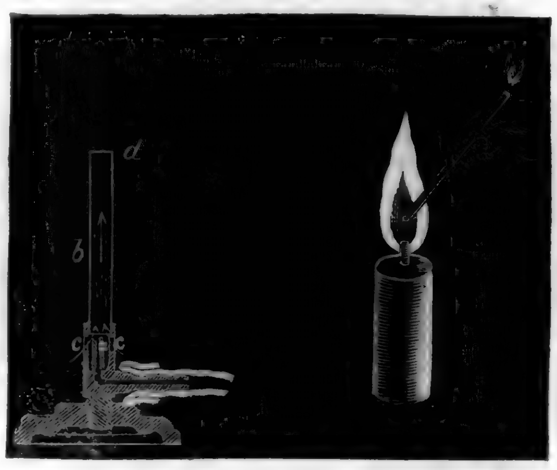


Fig. 338. Fig. 339.

was explained in answer to Question 554. To relight them with certainty it is necessary to keep a constant temperature in the fire-box high enough to ignite the gas which escapes or is distilled from the coal.

Second. That the chemical change in combustion consists simply in the union of the elements burned with the oxygen of the air; and, therefore, to burn the gas perfectly, without smoke or waste, *enough* air must be furnished to supply all the oxygen which will combine with the fuel.

Third. That the air must be mixed with the gas, otherwise combustion will occur only at the surface of the flame, and will therefore be so slow that much of the gas will escape unconsumed.

It must be clearly kept in mind that no one or two of these

requirements alone, without the third, will burn coal perfectly. What is needed is all three in combination. A very common error is to suppose that passing smoke over a hot fire, or, in other words, maintaining an igniting temperature, will alone effect perfect combustion; or that if a sufficient supply of air is admitted, without an igniting temperature in the fire-box, the fuel will be burned completely. Neither of them will accomplish the object alone, and the gas and air must at the same time be thoroughly mixed with the burning gas in the fire-box.

QUESTION 561. *What substances are produced by the combustion of coal gas?*

Answer. The hydrogen of coal gas unites during combustion with oxygen in the proportion, as indicated by their chemical equivalents, of 1 part by weight of hydrogen with 8 parts of oxygen, the product of which is water. Of course at the high temperature at which the gases combine or burn the water is produced in the form of steam. That water or steam is one of the products of combustion is shown every cold evening, when the insides of shop show-windows are covered with moisture, which is due to the steam that is given off by the burning gas-lights or lamps inside, and is then condensed against the cold glass.

Carbon combines with oxygen in two proportions: first, 6 parts of the former will unite with 8 of the latter, forming what is called *carbonic oxide;* or, 6 parts of carbon will combine with 16 parts of oxygen, forming *carbonic acid gas* or *carbonic dioxide*. *carbonic anhydride,* as it is called in some of the new books on chemistry. It is probable that the former compound, that is, carbonic oxide, is never or very rarely formed in the flame of coal gas; but, as will be seen hereafter, is a very common and wasteful product of the combustion of the solid portion of the coal which is left after the gas is expelled from it. When there is not enough oxygen for the perfect combustion of the carbon in the flame, it smokes, and the carbon escapes in the form of soot. This, as will be shown, may in a locomotive fire-box help to form carbonic oxide after it leaves the flame.

QUESTION 562. *What remains in the coal after all the gas is expelled by heat?*

Answer. What remains is ordinarily called coke, which, with the exception of some incombustible substances, such as sand, ashes, and cinders, which the coal contains, is nearly pure carbon.

QUESTION 563. *What is the chemical process of the combustion of coke?*

Answer. The solid carbon of the coke when raised to an igniting temperature; or, in other words, on being lighted, unites with the oxygen in one of the two proportions already given; that is, if the supply of oxygen is sufficient, 6 parts of the carbon of the coke unite with 16 parts of oxygen, forming carbonic acid gas, or carbonic dioxide. If, however, the layer of fuel on the grates is thick, or the supply of air is comparatively small, there will not be enough oxygen to supply 16 parts of the latter to each 6 parts of the carbon, so that when that occurs, instead of combining in that proportion, and thus forming carbonic dioxide, 8 parts of oxygen will unite with 6 parts of carbon and form carbonic oxide. Now it should be carefully kept in mind that the heat of combustion is due to the union, or, as it is sometimes expressed, it is the clashing together of the molecules of the two elements which unite. If, therefore, only half the quantity of oxygen unites with 6 parts of carbon, evidently there will be less heat evolved than there would be if twice that amount of oxygen combined with the carbon. From carefully made experiments it was found that the total heat of the combustion of one pound of carbon when converted into *carbonic oxide* was 4,400 units, whereas when it was converted into *carbonic dioxide* 14,500 units were given out. It will thus be seen that it is extremely wasteful to burn coal without a sufficient supply of air to produce carbonic dioxide. The danger of waste from this cause is also increased by the fact that carbonic oxide is colorless and odorless, and therefore its production is not apparent, especially as most persons have the impression that when there is no smoke from a fire combustion is then complete. It burns with a blue or yellowish flame when air is admitted into the fire-box, and its presence can often be detected by these phenomena when the furnace door is opened.

QUESTION 564. *How can the requisite quantity of air be supplied to the fire in a locomotive fire-box?*

Answer. It is done in two ways: one way is to keep but little coal on the grates, or, in the phraseology of firemen, to "carry a light fire." The other method is to admit fresh air above the fire. If the latter plan is adopted when the supply of air through the grates is insufficient for perfect combustion, the carbonic oxide will unite with the oxygen of the air above the fire, and thus a second combustion will take place, the product of which will be carbonic dioxide. It must be kept in mind, however, that not only must there be enough air supplied to the fire to consume the coke, but the gases which are distilled from the coal must also be supplied with oxygen in order to effect their perfect combustion. Even if enough air is admitted to consume the coke perfectly, if the carbonic dioxide thus formed is mixed with large quantities of smoke above the fire, the solid carbon or soot of the smoke may then combine with the dioxide and thus form carbonic oxide, if there is not enough fresh air present to furnish the requisite oxygen for the carbon in the smoke. A very common error is to suppose that smoke can be burned by passing it over or through a very hot fire. The smoke may thus be made invisible, it is true, but it does not therefore follow that it is perfectly consumed.

QUESTION 565. *Is it possible to admit too much air into the fire-box of a locomotive?*

Answer. Yes; probably all the air that is admitted which is not necessary for combustion, or, in other words, the oxygen of which does not combine with the fuel, instead of increasing diminishes the amount of steam which is generated. It does this in two ways: first, by reducing the temperature of the gases in contact with the heating surfaces, and, second, by increasing the volume or quantity of the gases which must pass through the tubes. Heat is transmitted through the heating surface of a boiler in proportion to the *difference* of the temperature of the products of combustion on one side, and the water on the other.* Thus, if the temperature of the water on one side is 250 degrees, and the hot gases on the other is 500, there will be only half as much heat transmitted to the water in a given time as there would be if the gases had a temperature of 750 degrees. If the volume of gases is doubled by the admission of too much air, then obviously in order to pass through the tubes they must move at double the velocity, so that not only is their temperature reduced, but the time they are in contact with the heating surface is diminished in like proportion. This is shown by the effect of opening the furnace door, or of allowing the fire to burn away so that portions of the grate are left uncovered. The volume of cold air which will in either of these cases enter the fire-box will be so great that the pressure of the steam in the boiler will begin to fall at once.

QUESTION 566. *What determines the amount of air which must be admitted to the fire-box of a locomotive to effect perfect combustion?*

Answer. This depends chiefly upon the *rate of combustion*—that is, the number of pounds of coal consumed per hour on each square foot of grate surface. Of course if 100 lbs. is burned it will require twice the supply of air that would be needed if only 50 lbs. were burned.

QUESTION 567. *How should the air be admitted so as to burn the coal perfectly?*

Answer. In burning bituminous coal it has been shown that there are two distinct bodies to be dealt with, the one coke, a *solid*, the other coal gas, which is, of course, a *gaseous body*. The combustion of each of these is necessarily a distinct process. If the requisite quantity of air is supplied to the burning coke, or solid portion of the coal, it will, as has been shown, be converted into carbonic dioxide, and thus be perfectly consumed. If the supply of air is insufficient, the product of the combustion will be carbonic oxide, which is very wasteful. If, for example, there is a thick layer of coke on the grate, the air will enter and unite with the lower layer of coal and form carbonic dioxide, but as it rises there will not be enough air to supply oxygen to the carbon, and another equivalent of the latter will therefore combine with the carbonic dioxide and form carbonic oxide. It is evident, though, that the thinner the fire, the easier it is for air to pass through it, and consequently the greater will be the quantity which will enter the fire-box. Nothing would seem easier, then, than to regulate the thickness of the fire on the grates, so that just the needed amount of air would pass through it. If coke alone was to be burned, undoubtedly very perfect combustion would be (and has been) effected in this way; but if a charge of fresh coal, say 100 lbs., is thrown on the fire, coal gas is very soon generated and escapes into the fire-box. This gas needs an additional amount of air for its combustion. It would seem that this could be supplied by reducing the thickness of the fire still further, so that more air would pass through it than was needed for the combustion of the coke alone. If this was done, then too much air would pass through the coke after the gases had all escaped from the fresh coal and were burned. Besides, the passage of the air would be the most restricted after the fresh charge had been put on the fire, just at the time when the most is needed. This difficulty might be overcome if a constant supply of fresh coal just equal to that consumed were kept on the fire all the time, and the thickness of fuel on the grates was then regulated so as to admit just air enough for the combustion of the coke and also that of the gases, the production of which

* This law is perhaps not absolutely correct, but is near enough for our present illustration.

would then be uniform. An approximation to this method of feeding the fire is, in fact, what is aimed at on most locomotives, and probably the best practical results are produced by that method.

Two difficulties are, however, encountered in this method. In the first place, it is impossible to feed a fire continuously with a shovel. There will be intervals between the charges which are thrown in, so that the supply is not uniform, even if the charges do not consist of more than a portion of a shovelful at a time; and if the fire was fed in this way as uniformly as possible it would then be necessary to open the furnace door every time fresh coal was put on the fire, and so much cold air would thus be admitted that more would be lost by lowering the temperature of the boiler than would be gained by the improved combustion.

Another difficulty also is encountered in this method of burning coal in locomotives. In order to admit enough air through the fire it is necessary to keep the latter so thin on the grates that the violent draft produced by the blast lifts the coal from the grate-bars and carries the lighter particles through the flues unconsumed. It is thus extremely difficult to keep the grate uniformly covered with coal, and if it is not, the air will enter in irregular and rapid streams or masses through the uncovered parts, and at the very time when it should be *there* most restricted. Such a state of things at once bids defiance to all regulation or control, so that it is found almost uniformly that firemen of locomotives keep enough coal on the grates to avoid the danger of "losing their fire," as they express it—that is, having all the burning coal drawn through the tubes by the blast. *Now, on the control of the supply of air depends all that human skill can do in effecting perfect combustion and economy;* and unless the supply of fuel and the quantity on the bars can be regulated, it will be impossible to control the admission of the air.*

Another method of feeding locomotive boilers is to pile up the coal in the back part in a thick layer as shown in fig. 346, and slope it downward toward the front, so that there is a comparatively thin fire in front. The mass piled up at the door becomes converted into coke, and the production of gas from the coal is more gradual and uniform than it is when only a small quantity is thrown in at a time, and therefore a more uniform supply of air is needed for its combustion. But it is apparent that very little air can pass through the thick heap of coal at the back part of the fire-box, and that therefore all, or nearly all the air which enters it must come in through a comparatively small portion of the grate. It will of course be difficult to admit the requisite quantity, for the reasons already stated.

It is therefore apparent that it is practically impossible to admit enough air through the grates to effect a constantly perfect combustion of bituminous coal. It is, consequently, necessary to admit a portion of the air above the fire. When this is done the air thus admitted must be thoroughly mixed with the gases, to effect perfect combustion and in order to be able to enter into chemical combination, or, in other words, to burn, the gases must combine with the air at an igniting temperature. If too much air is admitted, it will reduce the temperature in the fire-box so much that the gases will not ignite; or, if it is admitted in strong currents, the air and the gases will flow side by side like the currents of two streams of water, the one muddy and the other clear, which, as is well known, mingle very slowly. Besides, if a hot stream of gas encounters a strong stream of cold air and comes in contact with it only at its surface, the latter will be cooled down below the igniting temperature; whereas, if the two had been intimately mixed in the right proportion, the whole mixture would have been hot enough to burn. It is therefore of the utmost importance that the air which is admitted above the fire should enter the fire-box in many small jets. None of the openings for its admission should exceed half an inch in diameter. With the violent draft in a locomotive fire-box there is an extremely brief period of time for chemical combination to take place after the gases are expelled from the coal and before they are hurried into the tubes. As the chemical action between the gases and the oxygen can only take place when the two are in intimate contact, too much pains cannot be taken to distribute the currents of admitted air and thus mix them with the combustible gases. In many cases means are adopted to delay the air and the gases in the fire-box so as to give them time for chemical combination or combustion before entering the tubes.

QUESTION 568. *Does any combustion take place after the gases enter the tubes?*

Answer. Very little; as the flames are extinguished soon after they enter.

QUESTION 569. *Why are the flames extinguished in the tubes?*

Answer. They are then in contact with large quantities of incombustible gas and beyond the reach of a supply of air; besides, the temperature of the tubes which are surrounded with water is so low that the flame is soon cooled down below an igniting temperature.

QUESTION 570. *What temperature is necessary to ignite coal gas or produce flame?*

Answer. A temperature considerably hotter than red-hot iron is needed, as can easily be shown by the fact that a gas-light cannot be ignited with a red-hot poker.

QUESTION 571. *Are there any parts of the fire-box where the temperature is probably below the igniting point?*

Answer. Yes; along the sides and ends near the plates, which are covered with water on the opposite side. At these points the coal is usually "dead" or incandescent, as it remains at too low a temperature to burn. For this reason, in some cases a space of from 8 to 12 in. on each side and still more at the ends of the grates is made of solid plates, without any openings, and therefore called "*dead-grates,*" so that no cold air can enter at those points. These plates are made sloping downward from the sides toward the center of the fire-box, so that the coal which falls on them and is thus coked can easily be raked toward the middle of the fire. This arrangement of dead plates often improves the combustion and results in greater economy of fuel. The reduction of the area of the openings between the grate-bars can usually be compensated by making the bars narrower or the spaces between them wider.

QUESTION 572. *What should be the condition of the coal when it is put on the fire?*

Answer. It is true of the coal as well as of the gases that the chemical action between it and the oxygen can only take place when the two are in intimate contact, and therefore the rapidity and completeness of combustion and intensity of heat will be increased by increasing the number of points of contact, or by reducing the size of the fuel. The coal should therefore be broken up, but not so small as to fall between the grate-bars or be carried out of the fire-box by the blast.

QUESTION 573. *What amount of air must be admitted to the fire to effect perfect combustion?*

Answer. It was stated that average bituminous coal contains about 80 per cent. carbon, 5 per cent. of hydrogen, and 15 per cent. of other substances. As a large proportion of the latter are incombustible, we will confine ourselves for the present to the consideration of the combustion of the hydrogen and carbon alone.

The hydrogen, as has been explained, unites with oxygen in the proportion by weight of one part of the former to 8 parts of the latter, and the product of this union is water or steam. As 36 parts of air contain only 8 of oxygen, IN ORDER TO BURN THE HYDROGEN IT MUST BE SUPPLIED WITH 36 TIMES ITS WEIGHT OF AIR.

In order to burn the carbon perfectly it must, as has been explained, be converted into carbonic dioxide, which consists of 6 parts of carbon and 16 of oxygen; and as air consists of 28 parts of nitrogen to every 8 of oxygen, we must furnish 72 parts of air to every 6 of carbon, or, in other words, CARBON NEEDS 12 TIMES ITS WEIGHT OF AIR FOR ITS PERFECT COMBUSTION.

Every pound of average bituminous coal therefore requires 1.8 lbs. of air to burn its hydrogen, and 9.6 lbs. for the carbon, or 11.4 for both. As a portion of the other substances of which coal is composed, besides the oxygen and hydrogen, which others have been classed as impurities, are combustible, there will be no material error if we estimate the amount of air required for the combustion of bituminous coal at 12 LBS. PER LB. OF FUEL. As each cubic foot of air weighs 0.08072 lb., 12 lbs. will be equal to

$$\frac{12}{0.08072} = 148.6 \text{ cubic feet of air,}$$

or, for the sake of even figures and a quantity which can easily be remembered, we will say 150 CUBIC FEET OF AIR ARE NEEDED FOR THE COMBUSTION OF EACH POUND OF COAL. This is the theoretical quantity of air which is needed for combustion. Now, unfortunately, the process of combustion in the fire-boxes of locomotives is one in which any very exact combination of the substances which unite is not possible with the appliances which are now employed. If, therefore, we admitted the exact amount of air given above, while some portions of the fire where combustion was not very active might have more air than is needed, other portions would have too little; and if the air is not very thoroughly mixed, the flame and burning coal may be surrounded with the products of combustion, which would exclude the air and thus reduce its effect upon the fire. For this reason, besides the air required to furnish the oxygen necessary for the complete combustion of the fuel, it is also necessary to furnish an additional quantity of air for the *dilution* of the

* The Combustion of Coal, by C. Wye Williams.

gaseous products of combustion, which would otherwise prevent the free access of air to the fuel. The more minute the division and the greater the velocity with which the air rushes among the fuel, the smaller is the additional quantity of air required for dilution. In locomotive boilers, although this quantity has not been exactly ascertained, there is reason to believe that it may on an average be estimated at about *one-half* of the air required for combustion.* We would therefore have as the quantity of air needed for combustion

$$150 + \frac{150}{2} = 225 \text{ cubic feet.}$$

This estimate is roughly made, but it is the nearest approximation at present attainable. It is probable that the supply of air required for dilution varies considerably in different arrangements of the fire-box and for different kinds of fuel, and it is possible that by admitting the air for combustion in small enough jets, and deflecting the currents of smoke and gases so as to cause them to mingle with the air, the quantity required for dilution might be reduced below that indicated by the above calculation. Undoubtedly all the air which is admitted into the fire-box which does not combine with the chemical elements of the fuel lessens the amount of steam generated in the boiler, both with reference to time—that is to say, per minute—and to fuel—that is, per pound of coal consumed. But with the present locomotive boiler it is simply a choice of two evils. If no more air is admitted than theory indicates to be needed for combustion, then, owing to the imperfect means which are usually employed to cause the air and fuel to combine, a portion of the latter will escape unconsumed; and if *more* air is admitted, the temperature of the products of combustion is lowered and their volume increased, the evils of which have already been pointed out. It therefore becomes a matter in which we are obliged to consult experience and determine by experiment what amount of air it is necessary to admit to the fuel to produce the most economical results.

QUESTION 574. *What proportion of the air should be admitted through the grate, and how much above the fire?*

Answer. This, too, is a question which can probably be answered best by consulting experience. The relative quantity of air required above and below the fire depends very much on the nature of the fuel. Coal which "runs together" or cakes very much or has a great deal of clinker in it, doubtless, will need more air above the fire than other coal which is said to be "drier," for the reason that it will be found impossible to admit so much air through the caking coal in the grate as through the other kind. An idea of the relative quantity which should be admitted above and below the fire may be found if we know how much air is needed to burn the solid carbon or coke which is left after the gas is expelled from it, and how much for the gas itself. The gas which is expelled from a pound of coal consists of about 0.05 lb. of hydrogen and 0.15 lb. of carbon. Now, it has been shown that hydrogen requires 36 times its weight of air to burn it perfectly, so that 0.05 lb. would need $0.05 \times 36 = 1.8$ lbs.; and carbon requires 12 times its weight of air, so that for 0.15 lb. of carbon $0.15 \times 12 = 1.8$ lbs. is needed, so that for both 3.6 lbs. of air is required for perfect combustion. As has been shown, 12 lbs. is needed to consume the whole of the fuel, so that 30 per cent. of the whole supply is required for the combustion of the gas alone. If this is diluted in the same proportion as that required for the combustion of the carbon, and it probably should be even more so, we would have 30 per cent. of $225 = 67.5$ cubic feet of air required for the combustion of the gas. It is certain, however, that the solid coke on the grates is not perfectly consumed, or, in other words, converted into carbonic dioxide, especially when the layer of it on the grates is very thick. When this is the case the air coming in contact with the lower layer of coke forms carbonic dioxide, but as it rises through the burning coke another equivalent of carbon unites with the carbonic dioxide, and thus forms carbonic oxide. If, now, enough air is admitted above the fire, this carbonic oxide will combine with it, and, as has been explained before, a second combustion will take place if there is time and opportunity for combination before the gases enter the flues. It is therefore probable that more than 30 per cent. of the whole supply of air should be admitted above the fire. It is at any rate best to provide the means for admitting more, and also appliances for regulating the supply, so that it can be governed as experience may indicate to be best.

QUESTION 575. *Is it not possible by enlarging the grate to admit enough air to the fire to produce perfect combustion?*

Answer. Yes; when no air is admitted above the fire, large grates are found to produce the best combustion. But while it is true that the same amount of heat will be produced by the union of each equivalent of oxygen and fuel, yet if we can force *more* air and fuel to unite in the *same place*, a higher temperature is produced in that place, just as a fire in a blacksmith's forge is hotter because of the forced blast than that in an ordinary stove, or a smelting furnace than a parlor grate. If, then, we can concentrate the draft in the fire of a locomotive, we secure a greater *intensity* of combustion; and when the air is urged against the solid carbon with considerable force, it comes in contact with every point of its surface, and therefore less dilution of the air is needed, and consequently the products of combustion have a higher temperature; and, as has been explained, a larger proportion of the heat is then transferred to the water than if the temperature is lower and the volume greater.

Intensity of combustion also has the effect of maintaining an igniting temperature; whereas, if the same amount of fuel is burned slowly, its heat may not be high enough to ignite the gases as they are produced.

It is desirable, however, to have all the space that is possible in the fire-box, so as to give room for the mixing of the gases; but with a large fire-box and large grate a decided improvement and economy will often result by diminishing the effective area of the grate by covering a part of it with dead-plates, but at the same time making provision for the admission of air above the fire.

QUESTION 576. *What is meant by the "Total Heat of Combustion?"*

Answer. It is the number of units of heat given out by the combustion of a given quantity (usually a pound) of fuel.

QUESTION 577. *How is this determined?*

Answer. The heat given out by the combustion of one lb. of the chemical elements of which coal is composed has been determined by experiment, and from such data, knowing the substances of which fuel is composed, we can determine the amount of heat which would be developed if they were each perfectly consumed. Thus the total heat of combustion of one pound of hydrogen is 62,032 units, and of the same quantity of carbon 14,500 units.* Therefore, if a pound of coal contains 5 per cent. of hydrogen, the heat given out by the combustion of that element will be $62{,}032 \times 0.05 = 3{,}101.60$ units, and if it has 80 per cent. of carbon, the combustion of the latter would develop $14{,}500 \times 0.80 = 11{,}600$ units, so that the total heat of the combustion of these two elements would be $3{,}101.6 + 11{,}600 = 14{,}701.6$ units. It was shown in answer to Question 62 that it required 1,213.4 units of heat to convert water at zero to steam of 100 lbs. pressure. As steam is usually generated from water at a temperature of about 60 degrees, the total heat required to convert it into steam of 100 lbs. pressure would be $1{,}213.4 - 60 = 1{,}153.4$ units. A pound of average bituminous coal, therefore, contains heat enough to convert $12\frac{1}{2}$ lbs. of water of 60 degrees temperature into steam of 100 lbs. absolute pressure. Ordinarily only about half that amount of water is evaporated in locomotive boilers per pound of fuel.

QUESTION 578. *What are the chief causes of this waste of heat?*

Answer. It is due, *first*, to the waste of unburned fuel in the solid state. This occurs when fuel which is very fine falls through the grates, or is carried through the tubes and out of the chimney in the form of cinders.†

Second, to the waste of unburned fuel in the gaseous or smoky state. The method of preventing this waste by a sufficient supply and proper distribution of air has been explained in the answer to preceding questions.

Third, to the waste or loss of heat in the hot gases which escape up the chimney or smoke-stack. The temperature of the fire in a locomotive fire-box in a state of active combustion is probably from 3,000 to 4,000 degrees. This heat is in part radiated and conducted to the heating surface of the fire-box, and it is found that more water is evaporated by this portion of the heating surface in proportion to its area than by any other in the boiler. The gases when they enter the tubes transmit a portion of their heat to the surfaces with which they are first in contact. The amount of heat thus transmitted, as has been stated, is in proportion to the *difference* in temperature of the gases inside the tubes and that of the water outside. After passing over the part of the tube with which the gases are first in contact, they then arrive at another portion of the tube surface with a diminished temperature, and the rate of conduction is therefore diminished; so that each successive equal portion of the heating surface transmits a less and less quantity of heat, until the hot air at last leaves the heating surface and escapes up the chimney with a certain remaining excess of temperature

* Rankine.

* The experiments which have been made to determine these amounts do not agree exactly, but those given are thought to be the most trustworthy.

† It should be remarked here that some, and perhaps many, of the cinders which are carried out of the chimney are not combustible, but are composed of the same materials that form clinkers on the grate.

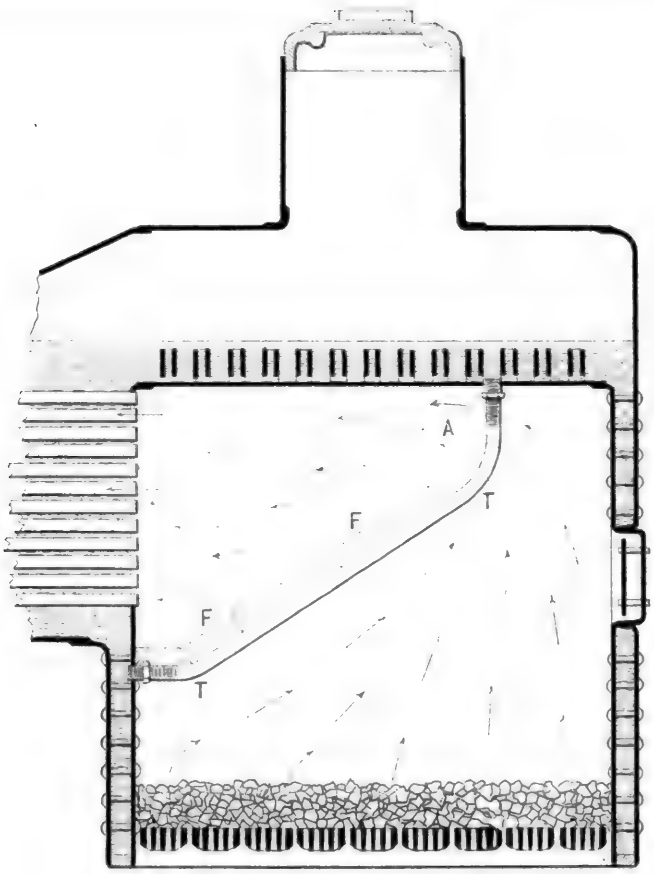


Fig. 340.

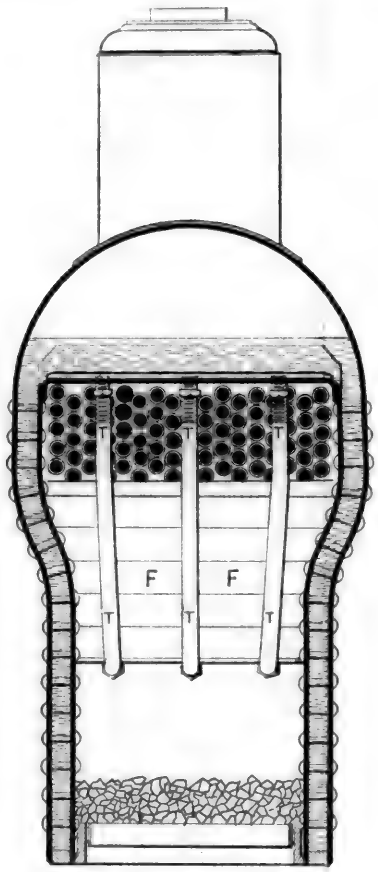
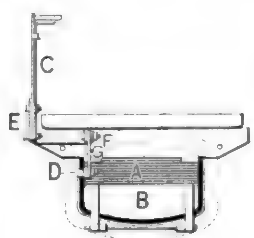


Fig. 341.

Fig. 344.



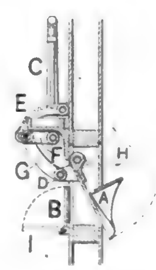
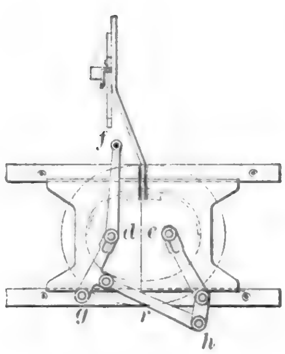


Fig. 345.

Fig. 343.



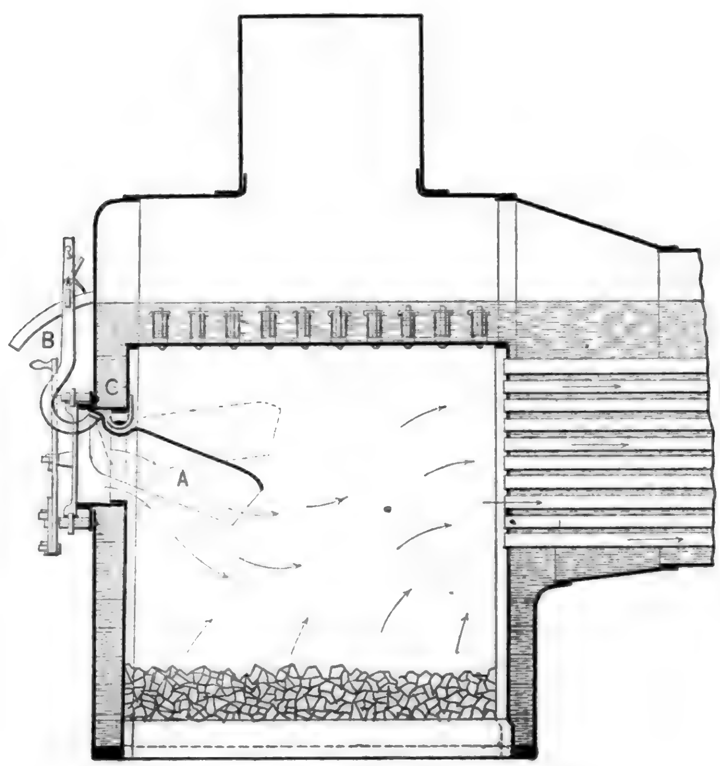


Fig. 342.

above that of the water in the boiler, the heat corresponding to which excess is wasted.* It is, therefore, desirable to extract as much heat as possible from the gases before they escape from the tubes. Now it will be impossible to heat the water outside of the tubes hotter than the gases inside. When the temperature of the water is equal to that of the gases, no more heat will be transmitted from one to the other. If the temperature of the water is 350 degrees, that of the gases in the tubes will never be any lower, but will escape into the smoke-box with not less, but usually considerably more, than that amount of heat. If, however, the cold water is introduced at the front end of the tubes, so that the surface with which the gases are last in contact has a temperature considerably lower than 350, then an additional amount of heat will be transmitted before they escape. It is, therefore, important that the cold feed-water should be admitted near the front end of the boiler, so that the products of combustion will be in contact with the coldest part of the heating surface last, and thus give out as much of their heat as possible before they escape. As a matter of fact, the gases escape at a much higher temperature. Experiments made by the writer showed that the temperature in the smoke-box of a locomotive when first starting was 270 degrees, and when working at its maximum capacity on a steep grade and with a heavy train it was as high as 675 degrees. The average temperature while running was, in three trials on different parts of the road, as follows:

Average steam pressure, 98.8 lbs.; average temperature, 499.8 lbs.
Average steam pressure, 106 lbs.; average temperature, 535.1 lbs.
Average steam pressure, 112.2 lbs.; average temperature, 554 lbs.

In making these experiments a record was made of the indications of a pyrometer and of the steam gauge once every minute while the engine was running. The distance run was 19 miles for the first experiment, 13 for the second and 6 for the third, with 30 loaded freight cars in the train. The last experiment was made while the engine was working on a heavy grade and very nearly up to its maximum capacity.

It will thus be seen that a great deal of heat is wasted by escaping up the chimney.

Fourth, by external radiation from the boiler. This occurs chiefly from the fact that it is not sufficiently well protected or covered with non-conducting material. The practice, or rather the neglect, of not covering the outside of the fire-box with lagging doubtless causes a very considerable loss of heat by radiation and convection from the hot boiler plates.

QUESTION 579. *What is the ordinary form of fire-box employed for burning bituminous coal?*

Answer. It is that represented in plate IV and figs. 90–92, and is simply a rectangular box, and for that reason it is often called a *plain* fire-box. Sometimes provision is made for admitting air into such fire-boxes through hollow or rather tubular stay-bolts, which are put into the sides and front. In most cases, too, the fire-box door has openings for admitting air.

QUESTION 580. *What other appliances are used for burning bituminous coal?*

Answer. The most common appliances which are added to the plain fire-box are what are called *fire-brick arches* or *deflectors*. These are sometimes made of an arched form, and rest on supports on the sides of the fire-box. In other cases the fire-brick, *F F*, figs. 340 and 341, is supported on tubes, *T T*, which are fastened to the front end of the fire-box and into the crown-sheet. These tubes permit the water in the boiler to circulate through them, which prevents them from being burned by the intense heat in the fire-box. The fire-brick deflector extends backward and upward from a point on the tube sheet a short distance below the tubes. A space *A* between the top of the deflector and the crown-sheet is left open, so that the smoke and gases from the fire must pass under the deflector and around and over its back end, as indicated by the arrows in fig. 340. In this way the products of combustion are delayed in the fire-box before they enter the tubes, which gives time for the gases and air to combine and combustion to take place. The fire-brick becomes heated, and thus to some extent prevents the gases from being cooled down below an igniting temperature by contact with the cold surface of the fire-box before combustion is complete. The fire-brick, however, soon burns out, and must often be replaced, but owing to its cheapness and the ease with which it can be removed, this is not a very serious objection to its use. Air is nearly always admitted above the fire when the brick arch is used, either by tubular stay-bolts or perforations in the door, or both.

When air is admitted at the furnace door of an ordinary fire-box, it is very apt to rush directly into the tubes without mingling with the gases. It was found by some of the firemen on English railroads that by placing an inverted shovel over the top of the furnace door, the current of air which entered could thus be deflected downward, and in this way smoke could be almost entirely prevented. This led to the adoption of a hood or deflector, *A*, fig. 342, which is made of sheet iron and is placed over the fire-box door, and is arranged with a lever, *B*, so that it can be raised in order to be out of the way when coal is thrown on the fire. It is suspended from a hook, *C*, from which it can easily be detached and taken out for repairs. This is frequently necessary, as the intense heat of the fire-box burns away the sheet iron of which it is made very rapidly. It can be made of old boiler plate, so that the expense of renewal is very slight. When this plan is used, a double sliding door, shown in fig. 343, is commonly used with it. These doors are opened by the levers *f d g* and *e h*, which are connected together by the rod *r*. With these sliding doors the opening for the admission of air can easily be regulated, and the opening through

Figs. 344 and 345 represent a furnace door used on an English railroad. The door *A* is hinged so as to open inward. It is opened and closed, and its position can be adjusted by the lever *C*. *B* is a door hinged at the bottom to protect the fireman from the heat of the fire. By leaving the door partly open air is admitted and deflected downward on the fire for the reason already described.

On the New York Central & Hudson River Railroad the form of fire-box, shown in figs. 346–348, which was designed by Mr. William Buchanan, Superintendent of Machinery of that line, is used quite extensively, and avoids the inconvenience and expense of frequently replacing the fire-brick and gives very perfect combustion. This consists of what is called a water-table, *A A*—that is, two plates with water between them similar to the sides of the fire-box. This extends completely across the fire-box from the tube sheet to the back-plate, thus dividing the fire-box into two compartments, *M* and *N*. In order to afford communication from the lower one to the upper one a round hole, *D*, about 18 in. in diameter, is put in the water-table in the position shown. It will thus be seen that all the currents of gas, smoke, and air must unite in passing through this opening, and are thus brought into close contact with each other. After they enter the upper chamber and before they enter the tubes, there is room and time for combustion. For the purpose of supplying fresh air above the fire, Mr. Buchanan puts four tubes, *A A A A*—shown in an enlarged scale in figs. 349 and 350—in the front and equal number in the back end of the fire-box just above the fire. These tubes each have a cone, *C*, which has an annular opening or space, *D D*, around it. The cone is held in position by the ribs *E E*, which are attached to it. Each of these tubes has a steam nozzle, *n n*, opposite to it. Steam is conducted to these nozzles by the pipe *F F—F*, the supply being regulated by the cock *G*. A jet of steam can thus be discharged into each one of the tubes, the effect of which is to create what is called an *induced* current of air into the tubes, or, in other words, the steam draws a large amount of air into the tubes with it. When the steam and air strike the cone *C*, fig. 349, it deflects or spreads them as indicated by the dotted lines which diverge from the nozzles in the different figures. The effect is to distribute and mix the air with the gases in the fire-box, and thus promote combustion. The furnace doors of these fire-boxes also has a deflector, *H*, and a movable damper, *I*, which is swung on trunnions so that its position can be adjusted by the latch *L*. The air can thus enter the fire-box through the door, and is deflected downward as indicated by the arrows in fig. 346. The direction of the smoke and gases is indicated by the arrows in fig. 346, which shows how they come into contact in passing through the opening *D* in the water-table. The steam jets and the furnace door furnish the means of supplying an abundance of air to the fire, which are intimately mixed below the water-table and in passing through the opening *D*, so that very complete combustion results in the chamber *M*.

QUESTION 581. *How do the plans for burning coal which have been described operate?*

Answer. They will all burn coal more perfectly, and therefore more economically, if they are carefully and skillfully managed, than is possible in ordinary plain fire-boxes; but it is probable that as much economy in the consumption of coal would result from the improvement of the practice and knowledge of firemen as can be expected from the use of any of the appliances described, if they are used without care or knowledge of the principles of combustion.

QUESTION 582. *In what respect does anthracite coal differ from bituminous?*

Answer. It differs chiefly in the fact that it contains a much larger proportion of carbon and less of hydrogen, and in the fact that it consequently gives off very little or no coal gas. Its combustion is therefore more simple than that of bituminous coal, as there is very little else than solid carbon to burn.

QUESTION 583. *In what kind of a fire-box is anthracite usually burned?*

* Rankine.

Fig. 346.

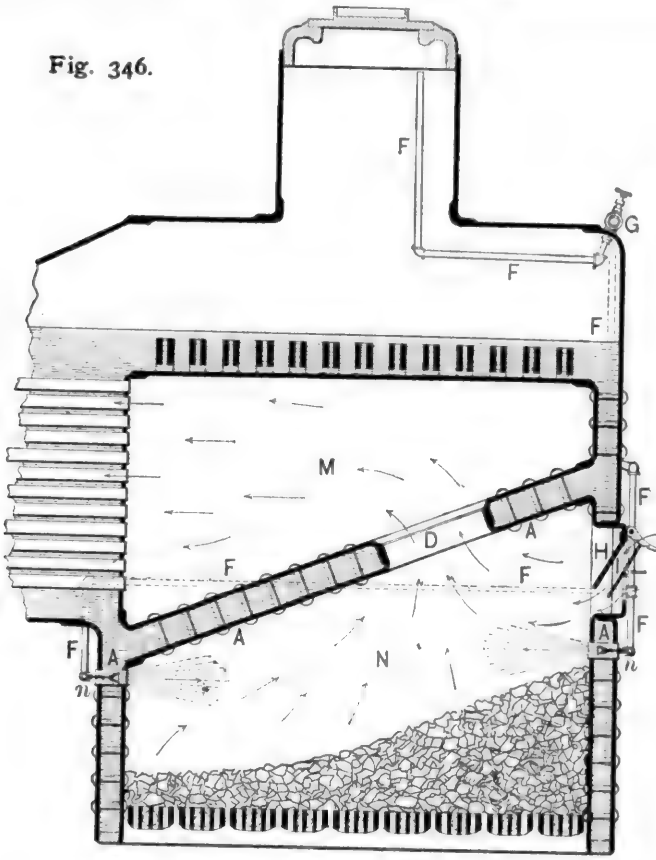
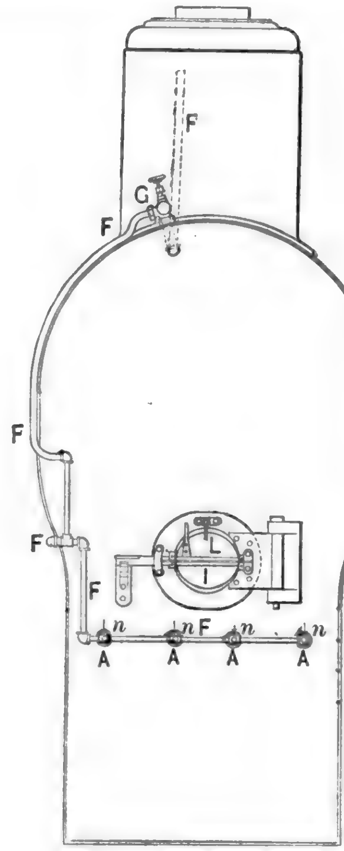


Fig. 347.



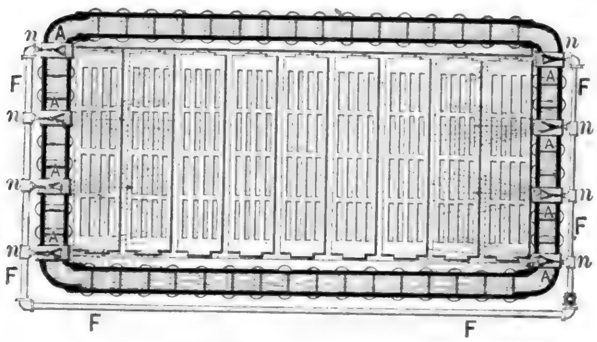
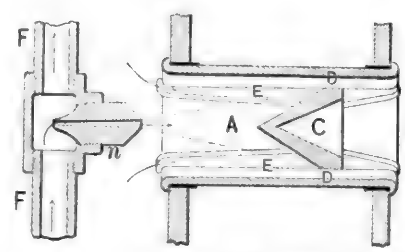


Fig. 348.



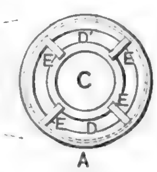
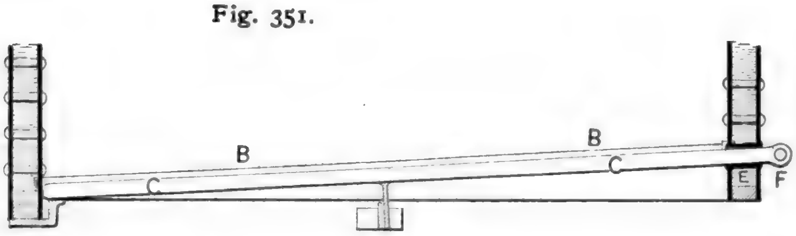


Fig. 349. Fig. 350.

Fig. 351.



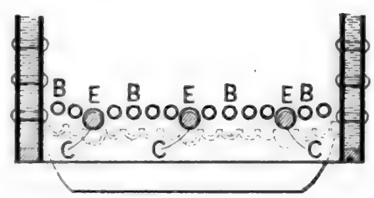


Fig. 353.

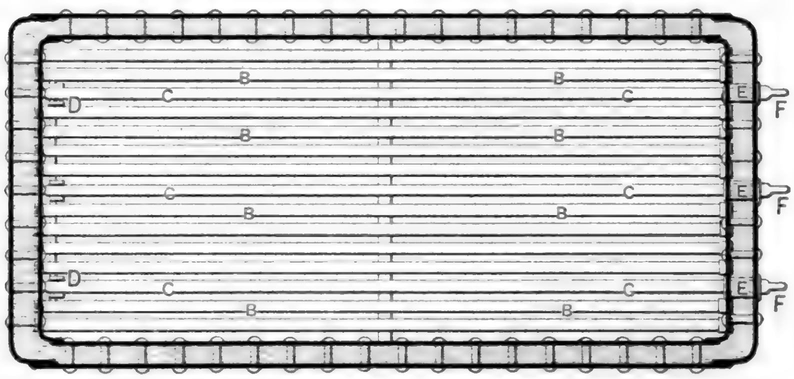


Fig. 352.

Answer. It is usually burned in a very long grate, and as the heat is very intense, the grate-bars *B B*, figs. 351–53, are usually made of iron tubes, through which a current of water circulates, so as to prevent them from melting. These tubes are screwed into the front-plate of the fire-box, and are fastened with tapered thimbles on the back ends, which are driven into holes in the back-plate so as to make a tight joint around the tube. As these tubes are fastened in the plates and are immovable, it is essential that some means be provided for drawing the fire from the fire-box. This is done by using a solid bar instead of a tube at intervals in the grate, as shown by *C C* in figs. 351–53. These solid bars rest on a support or bearing-bar, *D D*, as it is called, at the front end, and pass through tubes, *E E*, in the back end of the fire-box. These tubes are caulked in each plate so as to make them tight. The bars have eyes, *F F*, on the ends for drawing them out when the fire must be removed.

plates III and IV, and also in figs. 354 and 355. In the latter figures *A A* are the exhaust orifices or nozzles; *B* is the chimney; *C* and *D* are deflectors or plates in front of the tubes. The deflector *D* has a sliding door, *G*, which is moved up and down by the shaft *S*, which has arms, *H* and *I*, the former connected to the door by rods, *J J*, and the latter by another rod, *K K*, with the cab. *E E* is wire netting which has an opening or man-hole, *F*, also covered with netting, which can be removed to give access to the exhaust nozzles.

The purpose of the movable door or deflector, *G*, is to regulate the draft, the direction of which is indicated by the arrows.

QUESTION 587. *How does an extended smoke-box help to arrest sparks and cinders?*

Answer. By means of the deflectors the sparks are thrown forward into the extension of the smoke-box where the current of air and gases is not violent. As the wire netting at the same time offers some obstruction to the movement of the sparks, they are deposited in the extension of the smoke-box, from which they can be removed by means of the pipe *P*, which is closed by a sliding door, *L*.

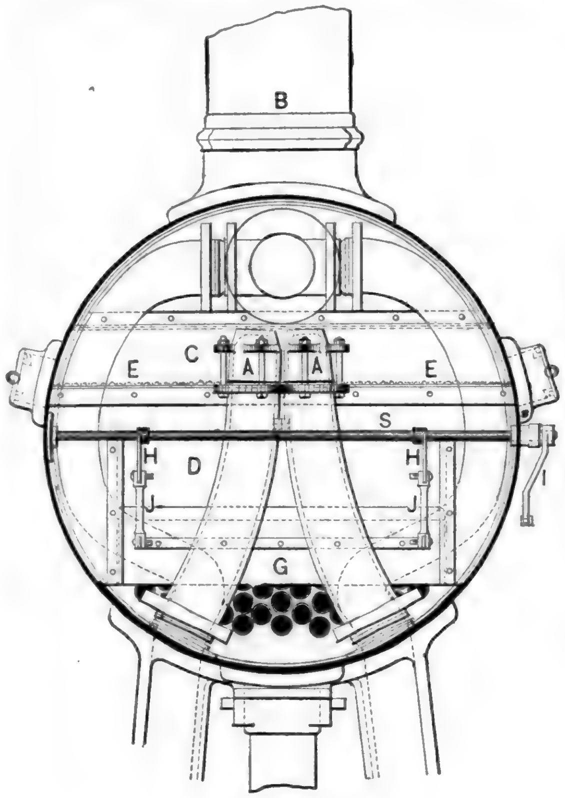


Fig. 354.

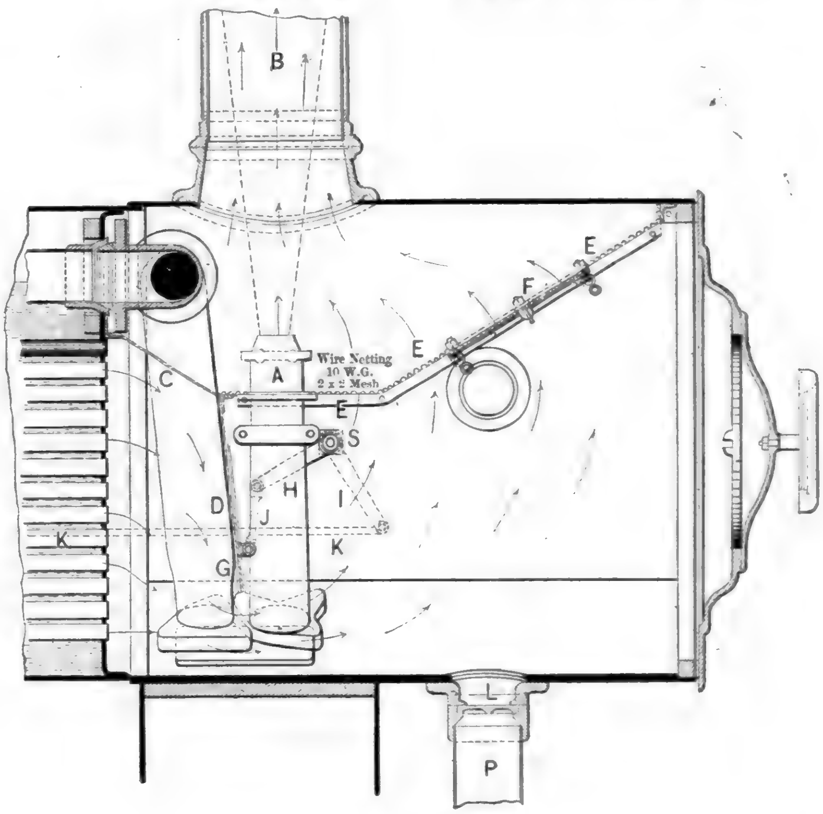


Fig. 355.

QUESTION 584. *Is it important to admit air above an anthracite coal fire to facilitate combustion?*

Answer. It is not so important as it is in bituminous coal, but if the layer of anthracite in the grates is very thick, it will be impossible to get enough air through the coal to convert all the carbon into carbonic dioxide, and the carbon and oxygen will therefore unite so as to form carbonic oxide. If air is admitted above the fire, as has already been explained, another equivalent of oxygen will unite with the carbonic oxide, and a second combustion will then take place above the fire, and the carbonic oxide will thus be converted into carbonic dioxide. If, under these circumstances, no air was admitted above the fire, the second combustion would not occur, and all the heat produced thereby would be lost.

QUESTION 585. *In what way is combustion influenced by the arrangements in the smoke-box of the locomotive?*

Answer. The draft is dependent on the proportions, location, and adjustment of the blast orifices and the other appliances used in the smoke-box. The smaller the blast orifices are the more violent will be the escape of steam and the draft of air through the fire. But the draft is also dependent on the arrangement and proportions of the wire netting, deflection chimney, and other appliances used in the smoke-box. No exact rules can be given for the arrangement of these parts, as the principles of their operation are still very imperfectly understood. The best arrangement for them must, to a very great extent, be determined by experiment.

QUESTION 586. *What is an extended smoke-box or extended front end, and what is it for?*

Answer. As its name implies, it is an extension of the smoke-box in front of the chimney, and its object is to give room for collecting sparks and cinders. Such a smoke-box is shown in

QUESTION 588. *How can we determine the relative value of different kinds of fuel for use in locomotives?*

Answer. This can only be determined satisfactorily by actual experiment. The chemical composition, excepting so far as it indicates the presence of deleterious substances, such as sulphur, ashes, clinkers, etc., affords but little assistance in determining the value of fuel. Nearly the same quantities of elements in different fuels may arrange themselves, before and during combustion, so as to produce very different series of compounds. It is true that the composition of coal gives us some indication of its heat-producing *capacity*, but the extent to which that capacity can be converted into actual steam in locomotive boilers depends to a very great extent upon the conditions under which the fuel is burned. It should also be remembered that the rapidity with which steam can be generated is a very important matter in locomotive practice. Whether a heavy freight train can be taken up a given grade, or a fast express make time, often depends upon the amount of steam which can be generated by the fuel in each second of time that the boiler is worked to its maximum capacity. Therefore any appliance for improving combustion, which reduces the quantity of steam which can be generated by the boiler in a given time, is quite sure to fall into disuse or be abandoned. It is of course often necessary to adapt the appliances for burning fuel to the fuel itself; and when a poor quality of the latter must be used, more boiler capacity must be given than is needed to do the same work with better fuel.

(TO BE CONTINUED.)

Manufactures.

The Strong Locomotive.

A LOCOMOTIVE of the Strong pattern,* built by the Hinkley Locomotive Company in Boston for the Strong Locomotive Company, and named the *A. G. Darwin*, has recently been running on the New York, Providence & Boston Railroad. This engine has the Strong boiler with double fire-box and is carried on 10 wheels, a four-wheeled truck forward, four driving-wheels 68 in. in diameter, and a pair of bearing-wheels under the fire-box. The two corrugated fire-boxes are 38 in. in diameter, and the boiler has 235 tubes. The engine weighs 60 tons, of which about 17 tons are carried on the truck, 36 tons on the drivers, and 7 tons on the bearing-wheels. The cylinders are 19 in. diameter and 24 in. stroke.

On Monday, December 3, on the invitation of the Strong Locomotive Company, a party of gentlemen interested witnessed the performance of this locomotive on the regular Shore Line Express, this train being taken from Groton to Providence, 63 miles, by the *Darwin*. The party returned from Providence to Groton on the following day, on the regular express train, leaving at 11.10 A.M., with the same engine.

On the trip eastward the train, which consisted of eight cars, left Groton 32 minutes late, and 17 minutes of this time was made up on the trip, the run of 63 miles being made in 1 hour 40 minutes, with five stops. The road is generally in very good condition, but on the 13 miles from Stonington to Groton work is in progress on a second track, and the changes at bridges, culverts, etc., made slow running necessary. The best speed made on this trip was 13 miles in 15 minutes, from Greenwich to Providence.

On the return trip the run from Providence to Wickford Junction, 20 miles, was made in 23½ minutes (with six cars), the engine running several successive miles in 62, 61, and 63 seconds. The supply of steam was abundant, the safety-valve blowing off nearly all the way. No attempt was made on this trip to secure any special economy or to take the quantity of fuel consumed.

The engine, as might be expected from the weight and the long wheel-base, is a very steady-running one. It also worked with remarkable smoothness for a new locomotive. The quick and comparatively quiet exhaust is a striking feature to any one riding in the cab.

The *Darwin* will probably remain on the New York, Providence & Boston road for a short time, and will then be tried on several other lines.

* The Strong locomotive was illustrated and described in the RAILROAD AND ENGINEERING JOURNAL for March and April, 1887, pages 105 and 160.

The Vogelsang Screw Propeller.

THE accompanying illustrations represent a new form of screw propeller invented by Mr. Alexander Vogelsang, which has been in use for some time with very favorable results, its application having in several vessels increased the speed without increasing the consumption of coal, in some cases even diminishing it.

It is a four-bladed screw, either cast in one piece or with

FIG. 1.

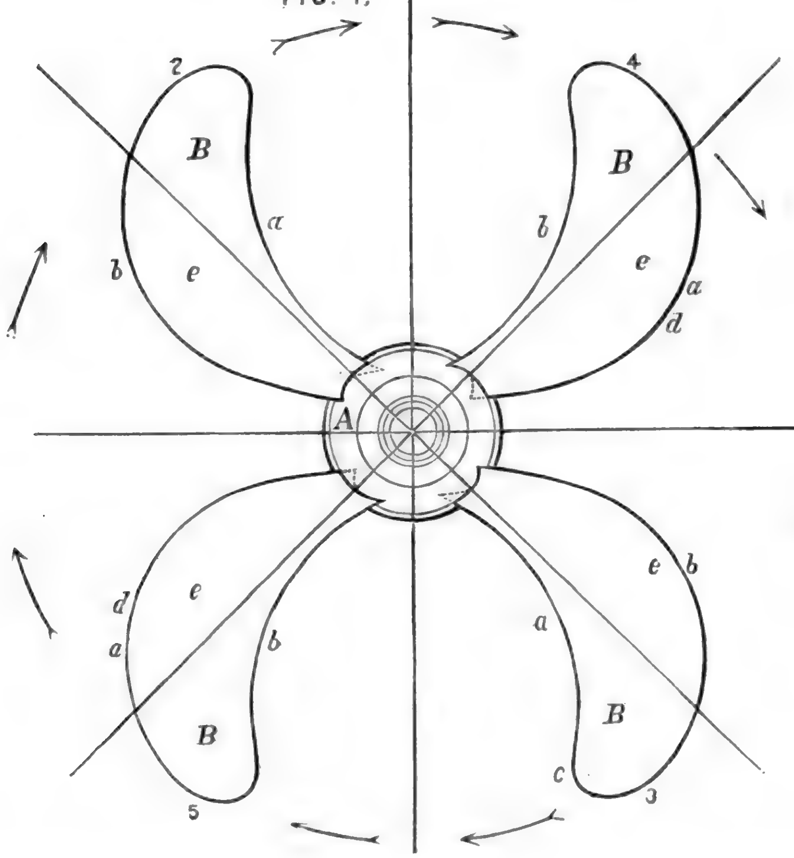
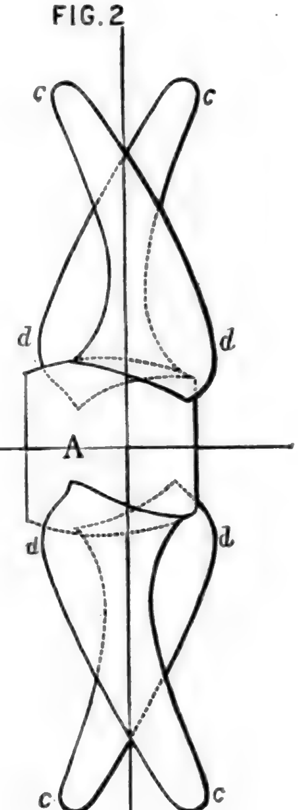


FIG. 2



blades adjusted, but differs from ordinary propeller screws in that the center lines of two following blades form spirals running in opposite directions. The Inventor describes it as follows:

"The edges of the blades do not coincide in a plane, but cross each other in such a manner that, supposing two successive blades were folded together round the axis, their leading and trailing parts would not cover each other in a plane of projection parallel to the axis. The blades are curved in such a manner that alternately one has its leading part near the periphery and the following one near the center, but the leading part of each blade will rotate in a plane that is in advance of the preceding blade. The blades diametrically opposite each other are alike, and the blades at their point of juncture with the hub are in approximately the same plane.

"As the screw is set in rotation, each blade cuts into water in advance of the preceding blade, and in no way comes in contact with the eddies created by the latter. Each blade, in fact, will act independently of and in no way interfere with the blades preceding or following it. In consequence of the difference in the manner in which the blades work, their reciprocal action is insured, the water is permitted to freely enter the screw from the direction in which it advances, centripetal, centrifugal, or back action cannot take place; therefore, no water is whirled around between the blades, and no thrust power neutralized by

water pressing against the back of the blades. Negative slip will not be observed with this screw.

"In reversing the direction of movement, the working order of the blades is simply reversed, so that when backing the vessel the same advantages are obtained, and the useful effect of this propeller will therefore be considerably greater in either direction than that of any other known propeller."

In the accompanying cut fig. 1 is a front view and fig. 2 a side view of the propeller.

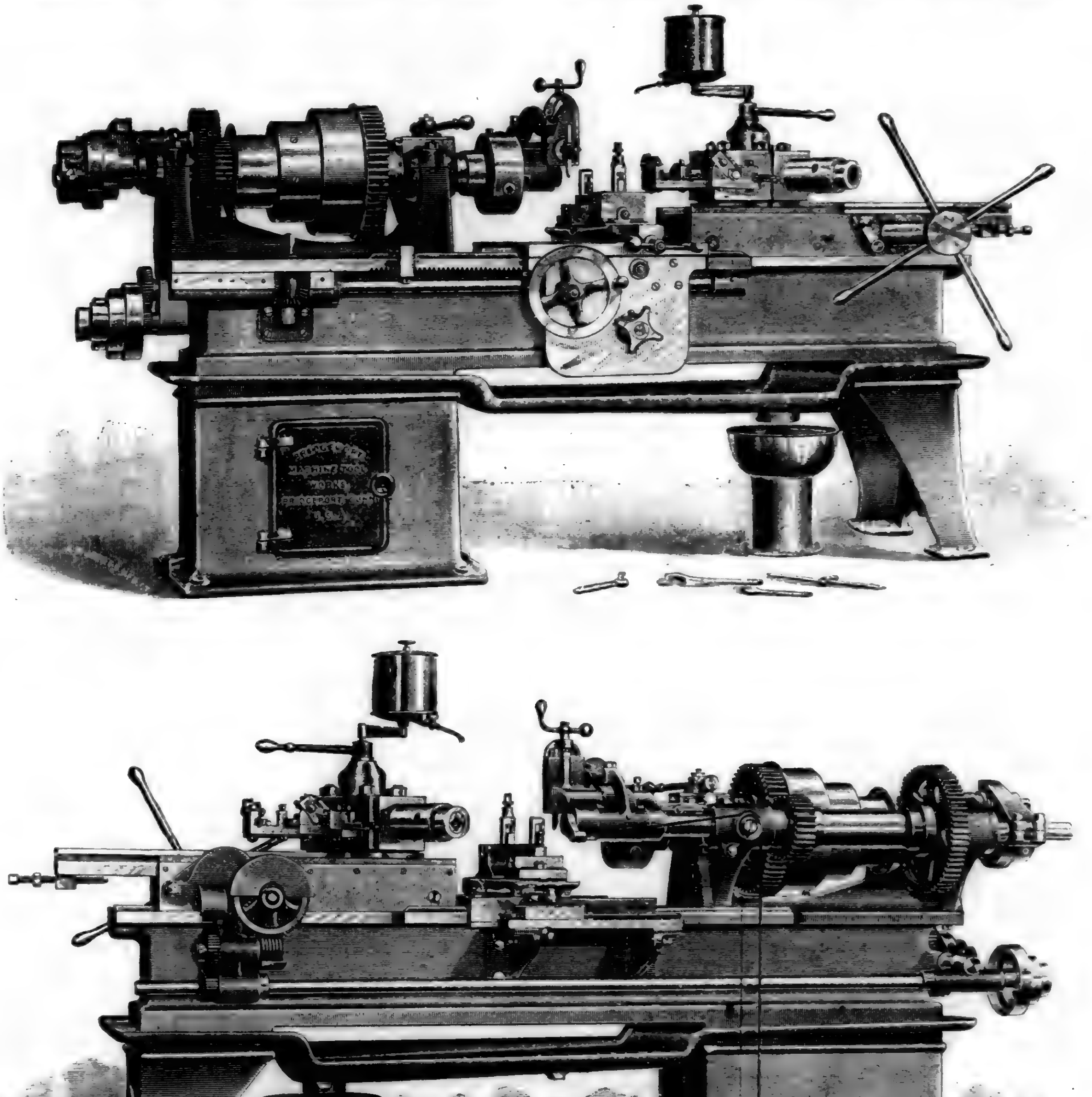
Among the advantages claimed for this screw by the inventor are, that it is the only one strictly in accordance with theory; that it is the only one drawing the full supply of water for its blade area from in front, and ejecting a cylindrical column of water equal to its diameter directly astern; that from its arrangement no blade will come in contact with disturbed water; that it causes no back action within its disk and does not carry any water around with it; that it will not lose in efficiency when the speed is increased; that it will not cause shocks or vibrations to the ship; that its backing power is much greater than that of any other screw. These claims seem to be substantiated by reports of the performance of the screw in actual service.

We are informed that one of these screws has been applied to the new German fast cruiser *Greiff*, with the result of increasing the speed from 19.75 knots to 22.8 knots per hour, the latter speed being the average of two days' continuous running.

A Combination Turret Lathe.

THE accompanying illustrations show a combination turret lathe made by the Bridgeport Machine Tool Works, at Bridgeport, Conn., which is intended for making screws or studs of all kinds up to 2 in. diameter, and also for general work. It is a tool remarkable for the variety of work which it is able to perform and for its careful design and construction.

The head has a three-section cone for a 4-in. belt, the largest section being 14 in. in diameter. It is provided with a patent friction clutch for instantly changing from belt speed to back gears without stopping. The gearing is proportioned to secure the proper relation of speed between the cutters and dies. The hole through the spindle is $2\frac{1}{4}$ in. in diameter. The chasing-bar is provided with proper leaders for cross pitches.



COMBINATION TURRET LATHE.

The machine is provided with a regular lathe carriage, which has reversible cross and lateral feeds and taper attachment; also three tool-posts to be used for studs and screws, or for general turning.

The turret is hexagon in form, 12 in. in diameter, with six 2½-in. holes, and has 14-in. automatic feed and stop motion, and is self-revolving. A substantial chuck for square, round, or hexagon iron is provided.

The counter-shaft has three pulleys 16 in. in diameter for a 4 in. belt, this giving two speeds forward (75 and 150) and one speed backward (150).

A great variety of tools is made for the turret, according to the needs of the purchaser and the work for which the lathe is to be used.

The illustrations show clearly the arrangement of the feed mechanism, etc., and the general construction of the machine. It may be mentioned that there is a provision made for turning tapers, which is done by means of a taper attachment, shown in the rear view, which also shows the arrangement of the chasing bar.

This lathe is a large and heavy machine, having 20-in. swing over the ways and 11½ in. over the carriage. Its entire weight ready for shipment is 4,500 lbs. Owing to the variety of work to which it is adapted, it must be an exceedingly useful tool in a machine shop.

Blast Furnaces of the United States.

THE *American Manufacturer's* usual monthly statement gives the condition of the blast furnaces on December 1, and says: "The totals are as follows:

Fuel.	In Blast. No.	In Blast. Weekly capacity.	Out of Blast. No.	Out of Blast. Weekly capacity.
Charcoal	73	13,270	95	11,329
Anthracite	107	31,052	89	23,082
Bituminous	151	94,960	75	34,736
Total	331	139,282	259	69,147

"Our table shows that the number of furnaces in blast December 1 was 331, compared with 313 on November 1—an increase of 18. The charcoal furnaces show a decrease of 2, the bituminous an increase of 10, and the anthracite an increase of 10, making the net increase 18. The weekly capacity of the furnaces in blast was 139,282 tons, compared with 130,270 tons on November 1. This shows a net increase of 8,562 tons—charcoal, decrease, 735 tons; anthracite, increase, 2,610 tons; bituminous, increase, 6,587 tons.

"The appended table shows the number of furnaces in blast on December 1, 1888, and on December 1, 1887, with their weekly capacity:

Fuel.	Dec. 1, 1888. No.	Dec. 1, 1888. Weekly capacity.	Dec. 1, 1887. No.	Dec. 1, 1887. Weekly capacity.
Charcoal	73	13,270	73	13,104
Anthracite	107	31,052	120	35,361
Bituminous	151	94,960	148	93,295
Total	331	139,282	341	141,760

"This table shows that the number of furnaces in blast this year was 10 less than at the same date in 1887, the changes being distributed as follows: Charcoal, 0; anthracite, decrease, 13; bituminous, increase, 3. The weekly capacity of the furnaces blowing was 139,282 tons; at the corresponding date last year, 141,760—decrease, 2,478 tons."

The estimated production of pig iron for the year 1888 is 5,956,000 tons, a decrease of about 461,000 tons, or 7½ per cent., as compared with 1887.

Child's Patent Piston Valve.

THE accompanying illustrations represent a new form of valve for steam engines invented by Mr. Franklin D. Child, Manager of the Hinkley Locomotive Works, and recently patented by him. In this arrangement, as will be seen, a separate steam-chest is dispensed with; the ports run entirely around the cylinder and are opened and closed by annular pistons working inside the cylinder itself. The valve is thus described:

"Fig. 1 is an end elevation of the larger part of a steam-engine cylinder having my invention applied thereto. Fig. 2 is a longitudinal section on line *x x* on figs. 1 and 5, but showing the piston and piston-rod in plan. Fig. 3 is a half-section on line *y y* on fig. 1, showing the piston, piston-rod, and valve-rods in elevation, and also showing a different packing for the valves. Fig. 4 is a transverse section on line *z z* on fig. 2. Fig. 5 represents in its upper half a transverse half-section on line *v v* on fig. 2, and in its lower half a similar half-section on line *w w* on fig. 2. Fig. 6 is a longitudinal half-section illustrating a form of my invention to be used in applying the invention to engines already in use, and fig. 7 is an end view of same.

"In the drawings, *A* is the steam-cylinder provided at one side and at or near the center of its length with the steam-inlet pipe *A'*, and at the opposite side with an exhaust-pipe, A^2, the former communicating with the semi-annular chamber *B*, which is separated from the semi-annular chamber *B'*, with which the exhaust-pipe communicates, by the partitions *a* and *a'*, which are shown in section in fig. 4, and one of which is indicated by dotted lines in fig. 2 and shown in longitudinal section in fig. 3.

"The semi-annular chamber *B* communicates with the annular steam-passages *b* and *b'*, which respectively extend from opposite sides thereof toward the opposite ends of the cylinder, as shown in fig. 2.

"The passages *b* and *b'* are annular or extend entirely around the inner wall of the cylinder from *c* to *d*; but from *d* to or nearly to the opening of the ports into the cylinder the inner and outer walls of said passages are connected together by the tie-ribs *e e*, thus dividing said passages each into a series of passages or ports, *e'*, opening into the cylinder upon all sides thereof, as shown in the upper half of fig. 5. In like manner, the semi-annular chamber *B'* communicates upon opposite sides with the annular exhaust-passages *f* and *f'*, which extend, respectively, toward the opposite ends of the cylinder from *g* to *h* in annular form, and from *h* to or nearly to the points where they open into the cylinder the inner and outer walls of said passages are connected together by the tie-ribs *i*, thus dividing said passages each into a series of exhaust-ports or passages, *i'*, opening into the cylinder upon all sides thereof, as shown in the lower half of fig. 5.

"*C* is the piston, of ordinary construction, and *C'* is the piston-rod, having a bearing in the packing-box *D* of the head *E* in a well-known manner.

"The heads *E* and *E'* are secured to the cylinder in the usual manner, and are provided upon their inner sides with large inwardly-projecting hollow hubs, which in the case of new engines are made in the form of frustums of cones, as shown in fig. 2; but when applied to remodelling old engines the said hubs are made cylindrical, as shown in fig. 6.

"*F F* are two ring slide-valves fitted to the inner bore of the cylinder, one at each end, and each provided with any suitable means of packing the same or causing it to work steam-tight upon its circular seat, whether the same be inside or outside of said valve. Said ring-valves are made thinner at their outer edges than at their inner edges, so that their non-working circular surfaces are oblique to the axis of the cylinder, as shown in figs. 2 and 6.

"The cylinder-head *E* is provided with two packing-boxes, E^2, for the passage of the valve-rods *G G*, by which said valves *F F* are connected together and made to move as one, said rods *G G* passing through openings in the piston *C*, provided with packing-boxes *j j* (see fig. 4) to prevent the passage of steam from one side of said piston to the other as the rods move through said piston or the piston moves upon said rods.

"The portion of the cylinder-head opposed to the oblique or frusto-conical surface of the valve is made parallel to said frusto-conical surface, and at such a distance from the valve-seat that when the valve is moved into position to open the steam-ports, said valve will substantially fill the annular space between the valve-seat and said frusto-conical surface of the head for the full longitudinal length of said valve, as shown at the right-hand ends of figs. 2 and 6, and when the valve is moved into position to close the steam-ports and open the exhaust-ports an annular space will be opened between the frusto-conical surfaces of the valve and of the head to permit the free passage of the exhaust steam to the exhaust-ports of the cylinder.

"The inclined circular sides of the valves *F F* are each provided with two ears, *k k*, upon opposite sides of the piston-rod, in which ears are formed openings to receive the valve-rods *G G*, and the inclined circular surfaces of the cylinder-heads opposed thereto have semi-circular notches cut therein to receive said ears, all as shown in fig. 5.

"For the purpose of remodelling old engines and applying my improved valves thereto, I make the steam-inlet and exhaust-nozzles and ports in the cylinder-heads instead of in the cylinder, and form the valve-seats upon the inwardly-projecting central portions of said heads, as shown in figs. 6 and 7.

"In some cases I propose to cut the tie-ribs *e* and *i* short of the inner periphery of the cylinder, as shown in fig. 3, thereby making a continuous port extending entirely around the cylinder, instead of making a series of ports separated only by thin partitions or ribs, as hereinbefore described."

The advantages claimed are the long port extending around the cylinder, thus giving full opening with a short stroke, and the reduction to a minimum of the space to be filled with steam at each stroke.

Marine Engineering.

THE Cleveland *Plain Dealer* publishes a list of new vessels under contract for service on the Lakes to be built during the present season. The total is 59 ships, with a carrying capacity of 100,950 tons, and to cost about $7,124,000. Last season there were built 60 vessels, with a capacity of 108,525 tons, and costing $8,325,000.

IN the yard of Neafie & Levy, Philadelphia, work has been begun on a new steam-tug 102 ft. long, 20 ft. beam and 10 ft. depth of hold. She will have a triple-expansion engine with cylinders 14 in., 21 in. and 36 in. diameter and 28 in. stroke.

A NEW steam-tug for Baltimore Harbor, just completed at the yard of John H. Dialogue & Company, Camden, N. J., is 106 ft. long, 21 ft. beam and 11 ft. hold, of iron, the plating being $\frac{7}{16}$ and $\frac{1}{2}$ in. The engines are triple-expansion, with cylinders 13 in., 21 in. and 32 in. diameter and 24 in. stroke. They will have about 150 lbs. working pressure of steam.

Manufacturing Notes.

THE contract for the tools for the new machine shops of the Louisville & Nashville Railroad at Decatur, Ala., has been taken by Manning, Maxwell & Moore, of New York.

THE Missouri Iron Roofing & Corrugating Company in St. Louis is very busy, having made large sales of its iron roofing and siding in the South and Southwest.

THE Cincinnati Corrugating Company has recently issued a circular giving a number of striking instances of long life of corrugated iron roofs under trying circumstances.

THE Bethlehem Iron Company, Bethlehem, Pa., is nearly ready to start up its new steel plant, which has been built chiefly for the purpose of making heavy forgings for guns and armor-plates. The first work done will be on the forgings for the 8-in., 10-in., and 12 in. guns for the Navy.

THE Sioux City Foundry & Machine Works, Sioux City, Ia., recently sold two of their 75 H.-P. Corliss engines for the new

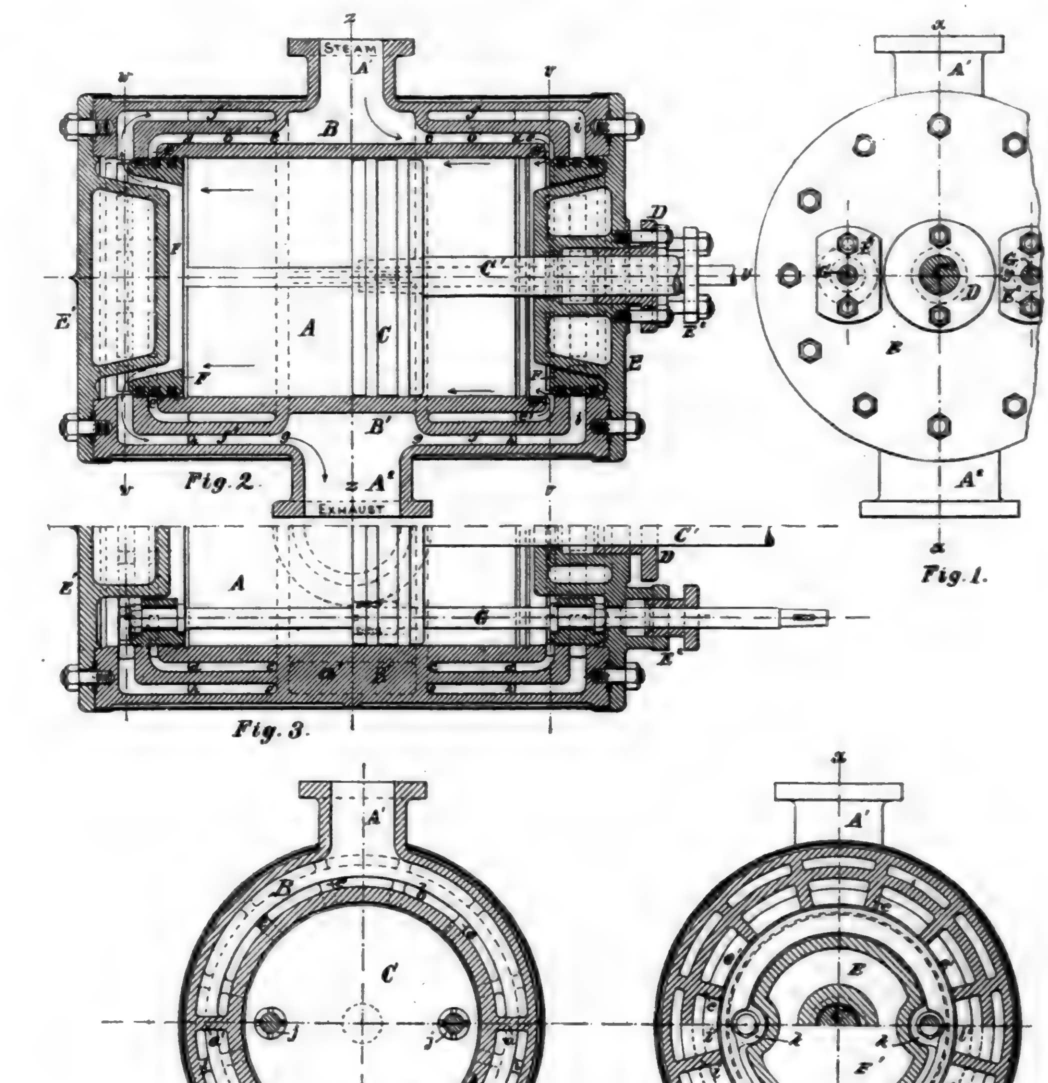


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7.

Pioneer-Press building at St. Paul, Minn.; also two others of the same size to run electric light plants at David City, Neb., and Storm Lake, Ia. These works also recently sold the first of a new line of engines, a 10 × 16 in. cylinder Giddings single-valve automatic engine for the water-works at Chillicothe, Mo. Arrangements are being made to manufacture several sizes of this engine. In addition to this the Works have recently sold several large boiler plants, together with a number of combined outfits of the Erie Engine Works, manufactured by Cleveland & Hardwick, of Erie, Pa., for which they are Western agents. They are still very busy improving their works, and are putting in at present a 90-in. fly-wheel lathe, also an overhead traveling crane, 30 ft. span and 7 tons capacity. Their foundry department is driven to its utmost capacity, being obliged to work evenings in order to get out the engine work in addition to the large amounts of architectural iron work which is required by the rapidly growing country surrounding them. They also report several sales of the Miller duplex steam pumps for boiler feeding.

Cars.

THE Muskegon Car & Engine Company at Muskegon, Mich., recently received an order for 500 box cars for the Chicago & Atlantic Railroad.

THE Peninsular Car Company, Detroit, Mich., has received an order for 350 box, 300 stock, and 450 coal cars for the Union Pacific Railroad.

THE car shops of Osgood Bradley & Sons at Worcester, Mass., are to build 20 passenger cars for the Boston & Maine Railroad, to be ready for next summer's travel.

THE Michigan Car Company in Detroit, Mich., has recently received contracts to build 650 box cars and 250 refrigerator cars for the Union Pacific Railroad Company.

THE Haskell & Barker Car Works at Michigan City, Ind., are to be enlarged by the erection of a new blacksmith shop 164 by 130 ft. in size, of brick.

THE Lehigh Car, Wheel & Axle Works at Catasauqua, Pa., have been enlarged by a new erecting shop 132 by 50 ft. in size. These works are filling a large order for the Lehigh Valley Railroad.

THE Milton Car Works at Milton, Pa., are building 500 box and 500 coal cars for the Central Railroad of New Jersey. Like most of the car shops, these works are very busy.

THE Wells & French Company in Chicago has an order for 150 coal cars for the Union Pacific Railroad, and is filling several large orders for other roads.

THE Pullman shops at Pullman, Ill., are to build 30 passenger cars for the Baltimore & Ohio Railroad. All of these cars will be equipped for steam heating, and part of them will be provided with vestibules.

Bridges.

THE Edge Moor Bridge Works have been organized at Wilmington, Del., to carry on the business of building bridges, roofs, etc., heretofore conducted by the Edge Moor Iron Company. That company will continue to carry on its other business, the bridge business only being placed under a separate management.

THE Dominion Bridge Company at Montreal has contracts from the Drummond County Railroad for the construction of two bridges over branches of the Nicolet River, near St. Leonard, P. Q. One bridge will have 160 ft. through span, 34 ft. above the river, and the other will have three 110 ft. deck spans, and 280 ft. of girder spans of 30 to 60 ft. each.

THE Milwaukee Bridge & Iron Company has taken a contract to build a bridge over the Saginaw River at Bay City, Mich. It will have a draw-span 240 ft. long and four fixed spans of 150 ft. each.

Electric Notes.

THE East End Electric Light Company has taken a contract to light the entire city of Pittsburgh with arc and incandescent lights for the year 1889 at a contract price of $110,592 per year. The Waterhouse system of arc lights, now owned by the Westinghouse Electric Company, will be used for the arc lights, while the Westinghouse system will be used for the incandescents. It is said that this is the lowest contract for electric lighting ever taken. The candle power of gas and gasoline used by the city now is 83,200: of electric light there will be 907,175, or ten times as much for less money. The cost per arc light per night will be about 29 cents. In Detroit it costs 62½ cents; Buffalo, 50 cents; New York, 50 to 70 cents; Baltimore, 40 cents; Philadelphia, 50 cents.

Locomotives.

THE Schenectady Locomotive Works, Schenectady, N. Y., recently delivered four engines to the Chesapeake & Ohio Railroad. These works are very busy, having a number of contracts on hand, including one for 25 locomotives for the Union Pacific.

THE Rhode Island Locomotive Works in Providence recently delivered five engines to the Chesapeake & Ohio Railroad. These works have recently taken orders for 15 locomotives for the Chicago, Burlington & Quincy and 25 for the Union Pacific.

THE Cooke Locomotive Works, Paterson, N. J., recently completed 10 locomotives for the Chesapeake & Ohio Railroad. They are at work on several large orders for different roads.

THE Rogers Locomotive Works, Paterson, N. J., have turned out a large number of engines during the past year, and are still very busy.

THE Baldwin Locomotive Works in Philadelphia in 1888 turned out nearly 700 locomotives, including several foreign orders. Among the large orders filled were 50 locomotives for the Pennsylvania Railroad and 60 for the Philadelphia & Reading. An order recently received is for 30 engines for a road in the Argentine Republic.

THE Canadian Pacific shops at Montreal are building 10 mogul engines for the road in addition to 20 recently completed.

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The following circular has been issued by the Secretary from his office, No. 45 Broadway, New York:

"At a meeting of the International Association of Accountants, held last June, the following resolutions were adopted:

"'*Whereas*, The rules of the Master Car-Builders' Association in regard to the proper marking of freight cars are being violated by various railroads and private car lines; therefore,

"'*Resolved*, That it is the sense of this Association that immediate steps be taken to prevent the placing of elaborate and superfluous marks and the names of more than one railroad, also misleading advertisements, upon freight cars, and that our Secretary is hereby directed to communicate with the Secretary of the Master Car-Builders' Association and respectfully ask that these rules be strictly complied with; and further,

"'*Resolved*, That members of this Association who are connected with roads which are guilty of the above violation, be requested to take this matter up with the proper officers of their respective roads, and endeavor to have the evil remedied.'

"The above resolutions were presented to the Executive Committee of the Master Car-Builders' Association at its last meeting, and the Secretary was then instructed to prepare a circular giving a statement of the above action of the International Association of Car Accountants, and announcing that the Executive Committee respectfully call the attention of members of the Master Car-Builders' Association to its action with reference to the adoption of standards for marking cars, and would suggest that these standards be conformed to as far as is practicable.

"A resolution was adopted at the Sixteenth Annual Convention (*see page* 158 *of Report*), requesting all railroad companies whose initials are the same as those of other railroad companies, to stencil the name of the road in full on some part of the car where it can readily be seen by freight agents.

"At the Eighteenth Annual Convention, held in Saratoga (*see page* 96 *of the Report of that meeting*), the following resolutions were adopted, which describe a proposed system of lettering and numbering 'Fast Freight Line' cars:

"1. The half of sides of car on which the doors do not slide, to show the name of the Fast Freight Line (spelled out in full) and the car number (in the Fast Freight Line series) immediately below it. In the same panel and within 2 ft. of the sill shall appear (in letters not over 4 in. high) the name of the railroad company owning or contributing the car, and between

the same and the sill shall appear the light weight of the car, with such other information as it is found advisable to give in connection with same.

"2. The doors should have no marks whatever.

"3. The ends to show the initials of the Fast Freight Line with the car number (in the Fast Freight Line series) and the light weight just below them; no other marks will appear on ends of car.

"4. The half sides of cars on which the doors do slide, to be reserved for advertising symbols or trade-marks where used. The use of profuse lettering in this panel is to be discouraged, however, and it is recommended that only the simplest trade-marks or advertising signs should be used; the capacity of the car to appear near the sill in this same panel."

The Engineers' Club.—In New York, December 4, a number of gentlemen interested in the formation of a social club whose object is to draw more closely together those engaged in the kindred pursuits, met at the rooms of the American Society of Civil Engineers, in New York. The organization was perfected, the incorporators being: James A. Burden, H. R. Towne, J. C. Bayles, A. C. Rand, David Williams, B. S. Church, Edward Cooper, Thomas Egleston, W. G. Hamilton, J. F. Holloway, W. A. Perry, J. C. Pratt, R. W. Raymond, and F. S. Witherbee. Its present officers are: James A. Burden, President; H. R. Towne and James C. Bayles, Vice-Presidents; A. C. Rand, Treasurer; David Williams, Secretary.

The responses received at an earlier stage of the movement encourage the belief that the new club will start with a large and representative membership. A circular has been issued to members of the three great engineering societies inviting their co-operation and placing before them the details. We may state that engineers residing within 150 miles of New York are eligible to membership, the initiation fee being $50 and the annual dues $35. For non-resident members the admission fee is $50 and the annual dues $20.

American Society of Mechanical Engineers.—Secretary F. R. Hutton has issued a circular announcing an invitation received from the Institution of Mechanical Engineers to a meeting to be held in London in May next. The programme proposed includes joint meetings with the English Society, several excursions, and a visit to Paris. The Secretary says:

"These communications have been before the Council of your Society, and the matter has been referred to the undersigned as a Committee to investigate and report. This circular has therefore been prepared, and is sent to all the members, with the request that each will reply stating his intentions. There must be a sufficient number of representative engineers who intend to go to make it expedient to accept the invitation. The Committee have the following facts: Minimum absence, five weeks. From last week in May to first week in July. Round trip passage by steamer, $110, going altogether in a body and returning individually at any time during the year, as may be convenient. Cost per day per person on shore from $4 upward, according to personal ideas.

"The trip will begin soon after the adjournment of the Erie City Convention of the Mechanical Engineers.

"The Inman Line will reserve for our party either the steamer *City of Richmond* or the *City of Chester*, giving us the entire first cabin for our exclusive use, provided we will guarantee 150 persons, including the ladies, at the above rates. By having our own steamer, the sailing day may be fixed to suit our convenience, to say nothing of the social advantage of being by ourselves and in control of the ship."

American Society of Naval Engineers.—The engineer officers of the Navy have formed themselves into a society known as the American Society of Naval Engineers, with the following officers: President, Chief Engineer N. P. Towne; Secretary and Treasurer, Assistant Engineer R. S. Griffin; Members of Council, the above-named officers, Passed Assistant Engineers G. W. Baird and A. M. Mattice, and Assistant Engineer Emil Theiss.

The object of the Society is to promote a knowledge of naval engineering by the reading, discussion, and publication of papers on professional subjects; by the bringing together of the results of experience acquired by engineers in all parts of the world, which, though valueless when unconnected, tend much to the advancement of engineering when published in the *Journal* of the Society, and by the publication of the results of such experimental and other inquiries as may be deemed essential to the advancement of the science. Engineer officers and persons in civil life who were formerly officers of the corps are eligible as members; persons in civil life whose knowledge of engineering is such that they can co-operate with naval engineers in the promotion of professional knowledge are eligible as associates.

American Society of Civil Engineers.—At the regular meeting, November 21, the Secretary read a paper by C. D. Purdon on the Construction of the Bridge over the Arkansas River at Van Buren.

Remarks were made by Charles Sooysmith, Charles Macdonald, Francis Collingwood, and T. C. Clarke about the sinking and adjustment of the caissons of the bridges at Van Buren, Havre de Grace, Md., Hawkesbury, in New South Wales, Poughkeepsie and Brooklyn, N. Y.

THE regular meeting was held at the Society's house in New York, December 5. The Secretary announced the death of Samuel B. Cushing, a member, and also of Henry W. B. Phinney, a member. The tellers announced the following candidates elected:

Members: Alfred Craven, Dobbs Ferry, N. Y.; George W. Freeman, Fort Stevens, Ore.; William E. McClintock, Chelsea, Mass.; Norman J. Nichols, Honda, Colombia; Henry W. Potter, City of Mexico; Edward H. Stone, Simla, India; Samuel C. Weiskopf, Pittsburgh, Pa.

Associate: John C. Trautwine, Philadelphia, Pa.

Juniors: Thomas W. Allen, New York; Mark Fargusson, Brooklyn, N. Y.; John M. Farley, Albany, N. Y.; Charles F. Wood, New Haven, Conn.

Mr. Edward Bates Dorsey then read a paper on English and American Railroads, comparing them with reference to their operating expenses and rates.

A circular has been issued by the Secretary calling attention to the invitation received by the Society to visit England in May next. It is necessary, in order to make proper arrangements for this trip, to find out how many members will go, and the circular is sent out for that purpose. It is very similar in terms to that of the Mechanical Engineers, published elsewhere.

United States Naval Institute.—At a meeting of the Institute held in Annapolis, December 14, Commander P. F. Harrington delivered a lecture on the Ram as a Naval Weapon. He referred at considerable length to experiments made abroad as to the causes of lack of "handiness" in certain ships, and said that further experiments were necessary. In war-vessels, as now constructed, quickness in turning was almost as essential as speed and other qualities. It has often been said that the speed of a fleet is that of the slowest vessel in it, and to this it may be added that the manœuvring of a fleet in action would practically depend upon the curve which can be described by the vessel with the poorest turning qualities. Quickness in turning and manœuvring is an essential quality in considering the power of the vessel as a ram.

New England Water-Works Association.—The regular quarterly meeting was held at Young's Hotel, Boston, December 12, with a large attendance. The first session was devoted to the consideration of general business, applications for membership, etc., and was followed by lunch.

At the afternoon session, after lunch, the following papers were presented: Construction and Management of Water Works, C. W. Kingsley, Cambridge, Mass.; Safe Ratio of Pumping Capacity to Maximum Consumption, W. B. Sherman, Providence, R. I.; Water in Some of Its Higher Relations, Rev. D. N. Beach, Cambridge, Mass.

Engineers' Club of Philadelphia.—At the regular meeting held November 17, the Secretary presented for Mr. A. A. Storrs a description of Poore's Endless Rope Hoist for Shafts, which is said to be especially adapted for very deep shafts.

Mr. J. E. Codman presented a paper on Indicator Cards from Compound Engines, showing expansion through high and low-pressure cylinders, profusely illustrated by large copies of diagrams, etc.

The paper was discussed by Messrs. H. W. Spangler and A. Marichal.

Mr. A. Marichal discussed the Plans of the Quaker Bridge Dam as proposed by the Board of Experts appointed by the New York Aqueduct Commission, and made comparisons between them and the plans presented by himself to the Commission at the beginning of this year.

There was some discussions by Mr. H. B. Seaman.

Mr. John T. Boyd presented for discussion a sketch of a de-

sign for a Stove for Heating and Steam Purposes, which he had seen in operation and which generated an apparently immense amount of effective heat in proportion to the coal consumed.

After some discussion, the Club adjourned.

At the regular meeting of December 1 the Tellers reported that the following were elected: *Active Members:* Sanford K. Campbell, Clifford Stanley Sims, Jr., John H. Webster, Jr., Walter Brinton, Albert S. Coffin, Charles Silliman, and Frederick B. Miles; *Associate Member:* Professor C. Herschel Koyl.

The Committee on Design and Inspection of Highway Bridges, etc., stated that they had no further report to make at present.

The Committee to Recommend a Practical Method of Testing Cements reported progress.

Officers, to serve during 1889, were nominated.

The Secretary presented, for Mr. Heber S. Thompson, a paper on Earth Embankments for Reservoirs.

Mr. Howard Murphy discussed this subject, presenting an informal account of a recent accident to a part of one of the basins of the reservoir at Roanoke, Va., when, after the explosion of a magazine containing three tons of dynamite and 400 kegs of powder, within 2,500 feet of the reservoir, a portion of the embankment of the south basin dropped into a limestone cavern or crevice, which was already known to exist under that portion.

Mr. L. F. Rondinella exhibited and described the Scale of Proportional Inches which he has prepared.

Mr. J. E. Codman presented a further discussion of his recent paper on Indicator Cards from Compound Engines, showing expansion through high and low-pressure cylinders.

Engineers' Club of St. Louis.—At the regular meeting in St. Louis, November 21, the following members were elected: Grant Beebee, Edmund Hall, William S. Love, William J. McNulty, R. L. Van Sant, and Arthur T. Woods.

Mr. Robert Moore read a paper on Smoke Prevention, in which he showed that no saving need be expected, but that experiments showed a loss of 40 per cent. in boiler capacity when making no smoke. Most smokeless fuels cost too much, as compared with ordinary coal, to come into general use. In the author's opinion, the fuel promising the best results at reasonable cost was petroleum, already coming into extensive use. The increased cost of insurance and the odor, however, were disadvantages. Good results might be secured from that class of smoke preventers which introduced air above the grates by means of steam jets, providing no injury resulted to the boilers.

This paper was discussed at much length by Messrs. Bryan, Meier, Wheeler, Bartlett, Holeman, Smith, Gale, and others.

It was decided to have the discussions at the Club meetings fully reported hereafter.

Arkansas Society of Engineers, Architects, and Surveyors.—The second annual meeting was held at Little Rock, November 22, 23, and 24. Several new members were chosen. The following officers were elected: President, Theodore Hartman; Vice-Presidents, A. B. Matson, Thomas Harding, and B. S. Wise; Corresponding Secretary, F. J. H. Rickon; Recording Secretary, F. W. Gibb; Treasurer, J. H. Haney.

The following papers were presented: Fort Smith Sewerage System, J. P. Bates; Municipal Improvement of Little Rock, G. P. C. Rumbough; Water-Works of Texarkana, A. B. Matson; Concrete in Construction, J. T. Hogane; Water-Works of Rogers, Ark., J. M. Whitham; Electric Lighting of Towns, W. E. Anderson; Arkansas Timber, E. C. Buchanan; What is Generally Expected of a Surveyor, W. E. Keefer; Descriptions in Deeds, B. S. Wise and William Mitchell; Construction of Hydraulic Rams, George C. Schoff; Uses of the Plane Table, D. C. B. Aiken; Highway Bridges, Lee Treadwell.

The meeting was well attended and successful.

Engineers' Club of Kansas City.—At the regular meeting, November 19, Dr. Wellington Adams gave an address on the Present Status of the Electric Railroad Problem, being in part a discussion of the paper read at the previous meeting. This was discussed by Messrs. Knight, Wynne, and Lawless, the latter giving a review of a recent trip of inspection of the electric street railroads of Allegheny City, Binghamton, Richmond, and Harrisburg.

The annual meeting was held in the Club-room in Kansas City, December 5. The report of the Executive Committee was presented by the President, and that of the Committee on Bridge Reform by W. H. Breithaupt. The Treasurer also presented his report. The report of the Secretary, Kenneth Allen, showed that during the past year there were held one annual, ten regular, and three adjourned meetings; it also gave a list of the papers presented by members, and recited the various actions taken by the Club. There are now 62 regular and 6 associate members. Many additions to the library were made during the year.

Nominations for officers for the ensuing year were made. It was voted to expend about $40 in subscriptions to leading engineering journals. Mr. Burton presented the Club with two photographs of a Corliss engine constructed by him.

Boston Society of Civil Engineers.—At the regular meeting, November 21, the Secretary read a paper by J. D. Mason describing the Flushing Tunnel recently constructed in Milwaukee.

Chief Engineer A. Fteley gave a description of the New Croton Aqueduct of New York, illustrated by lantern views.

Engineers' Club of Cincinnati.—The annual meeting was held December 5; seven applicants were elected members, increasing the membership to 75.

Colonel W. E. Merrill, the retiring President, read an address, reviewing in a brief but comprehensive manner the progress of engineering during the past year.

The following officers were then elected for the ensuing year: President, G. Bouscaren; Vice-President, G. B. Nicholson; Secretary and Treasurer, J. F. Wilson; Directors, Colonel W. E. Merrill, Latham Anderson, and R. L. Read.

Franklin Institute.—The subjects for the lectures to be delivered before this Institute during the month of January are as follows:

January 7: Relations Between Chemistry and Electricity; Professor Ira Remsen.

January 14: Interchangeable Work; W. M. Barr.

January 21: Manufacture of Bessemer Steel; Robert W. Hunt.

January 28: Debt of Medical and Sanitary Science to Synthetic Chemistry; Professor Samuel P. Sadtler.

Western Society of Engineers.—At the regular meeting in Chicago, November 14, Lewis P. Pennypacker was elected a member. The Secretary read a letter from Professor A. D. Conover, of the University of Wisconsin, stating that a system of tests of all cements used in this country had been undertaken, and requesting information. The Secretary was directed to reply.

The Committee on Bridges reported progress, and the question of legislation on this subject was discussed. The Secretary presented the question of requiring all plans for waterworks and sewerage to be approved by the State Board of Health, but no action was taken.

An interesting paper, on the Necessity of a Definite and Determinate System of Weights and Measures, by Mr. Charles C. Breed, was presented by the Secretary, and after brief discussion, ordered printed.

Mr. Weston gave an interesting account of a mammoth electric light plant now under construction in the city of London. A general discussion in regard to the application of any motor to direct propulsion on street railroads then ensued. There was some doubt of securing adequate adhesion under all the conditions of track obtaining in crowded cities.

A committee was then appointed to present at the next regular meeting a programme for the annual meeting, and to report upon nominations of officers and rules for their election.

At the regular meeting of December 5 the report of the Committee on Employment was laid upon the table, and the Chairman, Mr. Liljencrantz, wishes correspondence from members interested in the matter with a view of calling it up at a later date and disposing of it.

It was decided that the annual meeting should be held January 8, and that a lunch be provided. Nominations for officers, to be chosen by letter-ballot, were made.

Civil Engineers' Society of St. Paul.—At the meeting of November 5 the Secretary read a report on the standard form of Contract for Buildings as proposed by the National Association of Builders, and an informal communication from the Vice-President of the said Association recommending the members to use the form of Contract in any work they might let to which it was applicable.

Mr. J. D. Estabrook read a paper upon the Artesian-Wells of St. Paul and Vicinity and presented the Society with some blue

prints showing the location of the wells and a profile giving depth, elevation of ground surface, height of water in wells, and some information relating to the strata passed through. Beneath the drift formation are found layers of limestone and sandstone. The wells vary from 200 ft. to 1,600 ft. in depth, but few are flowing wells. The larger portion require the water to be pumped, and the deepest wells do not afford the largest supply of water.

The subject is of local interest at present, as the Board of Park Commissioners have under consideration the sinking of an Artesian-well to supply Como Park (200 acres) with water and to fill up Como Lake (50 acres) about 5 ft. to its former height, and to maintain it at that height by the water to be thus obtained.

AT the regular meeting of December 3 the paper of the evening was read by Mr. S. D. Mason upon the History of a High Viaduct built in 1883–84 by the Northern Pacific Railroad over Masent Gulch. The height of the viaduct at the centre is 216 ft. The timber was cut and sawed near the spot. The iron and supplies used were hauled by team for 80 miles. In 1885 the wooden structure was replaced by an iron viaduct from designs by George S. Morison, C. E. Mr. Mason's paper was illustrated by photographs of the wooden and of the iron structure and prints of the working drawings for the two structures.

New England Railroad Club.—The regular monthly meeting was held in Boston December 12. There was an interesting discussion on the Arrangement of Shops and Machinery for the Construction and Repair of Railroad Rolling Stock. The discussion was opened by Mr. J. W. Marden, and was continued by Messrs. Adams, Lauder, Griggs, Whitney, Coleman, and Professor Lanza, many statements of experience and practice being made.

New York Railroad Club.—At the meeting of November 15 Mr. James Howard read a paper on Train Brakes for Freight Cars, which was briefly discussed. Mr. R. W. Bayley read a paper upon the same subject, which was also discussed, and he was followed by Mr. Loughridge, who read a third paper on the same subject. This was followed by a general discussion of the whole subject of freight-train brakes.

AT the meeting of December 20 the subject for discussion was Car Wheels and Axles for 60,000-lbs. Freight Cars, the discussion being opened by Mr. J. R. Barr, of the Chicago, Milwaukee & St. Paul, who read a paper on this subject, also giving some notes of experience with the contracting chill process for making wheels.

Northwest Railway Club.—A meeting was held in St. Paul, Minn., December 1, at which a number of railroad men were present. W. T. Small was called to the chair, and H. P. Robinson appointed Secretary. After a brief discussion it was resolved to organize a society to be known as the Northwest Railway Club; to hold monthly meetings for the discussion of railroad questions, etc., in the same manner as the railroad clubs in Chicago, Boston and New York. Committees on constitution and on rooms were appointed, and were directed to report to an adjourned meeting, at which it was expected that a permanent organization would be formed. The Club is intended to include in its membership the very considerable number of railroad men who have their headquarters in St. Paul and Minneapolis.

Western Railway Club.—At the regular meeting in Chicago, December 18, the first subject for discussion was: Relative Merits of Thick and Thin Tires; and to what Extent are the Railroads Moving to Adopt the Master Mechanics' Standard Sizes of Tires and Wheel Centers.

The second subject was Water Circulation and Purification of Water for Boilers. This subject was opened by a paper written by Mr. Herbert Hackney, of the Atchison, Topeka & Santa Fé Railroad.

OBITUARY.

JOHN REMSEN ONDERDONK, who died in Chicago, November 22, aged 48 years, was born in New York, and was educated as an architect and civil engineer. He was for a long time employed on the Central Pacific Railroad, having superintended the grading of a large part of the main line of that road. He was also employed in designing and superintending some of the most important works about the harbor of San Francisco. For some time past he has had charge of the construction of the new water-works tunnel in Chicago.

J. F. COIGNET, the French engineer, whose death has just been announced, was well known by the association of his name with the *beton agglomere*, invented by him in 1855, and used in the foundations of the Vanne Bridge and the Port Said Lighthouse, and other important works. He was a member of La Société des Ingenieurs Civils, and prominently identified with industrial inventions for the last 40 years.

GENERAL JAMES C. LANE, who died in New York, December 12, aged 65 years, was for many years a civil engineer. Nearly 40 years ago he was employed in the surveys and construction of the Illinois Central Railroad, and was afterward for several years on the United States Coast Survey, and was then for some time engaged in mining surveys in Cuba and Porto Rico. He served in the Army during the war, and afterward was employed in mining surveys in California, Arizona, and Nevada. He was Chief Engineer of the South Side Railroad of Long Island. Recently he was employed in laying out the proposed new parks in the Annexed District of New York.

GENERAL THOMAS J. POWERS, who died in Rochester, Pa., December 1, aged 81 years, was one of the oldest civil engineers in this country. His first work was done as Assistant in the construction of the Erie Canal, and he was employed afterward on the Rome & Oswego and other railroads in New York; on the old Portage Railroad over the Allegheny Mountains; on the Virginia Central (now the Chesapeake & Ohio), and on improvements on the Kanawha and Monongahela rivers. General Powers retired from active work several years ago.

COLONEL ROBERT R. BRIDGERS died suddenly in Columbia, S. C., December 10, aged 71 years. He was born in North Carolina and trained as a lawyer, and in 1865 was chosen President of the Wilmington & Weldon Railroad Company, holding that position until his death, and serving also for a number of years as Manager of the Atlantic Coast Line, of which his road was a part. It was mainly due to his ability as a manager that the Wilmington & Weldon Railroad recovered from the prostrate condition in which it was left after the war and became a solvent and prosperous company, and under his charge numerous branches and extensions were built. Colonel Bridgers acted for several years as President of the General Time Convention, and was active in other railroad associations.

DAVID A. STEWART, who died suddenly in Pittsburgh, December 14, aged 57 years, was born in Chambersburg, Pa., and at an early age removed to Pittsburgh, where his father was the first ticket agent for the Pennsylvania Railroad. When quite young he was appointed clerk in the Pennsylvania Railroad freight station at Pittsburgh, and afterward gave up that business to enter the Columbia Oil Company, with which he was connected for a number of years. He afterward became one of the owners of the Pittsburgh Locomotive & Car Works, and has been for a long time President of that corporation. In 1872 he engaged with his present partners in the construction of the Edgar Thomson Steel Works, and soon after entered the firm of Carnegie Brothers & Company. For several years past, besides the presidency of the Locomotive Works, he has held the office of Chairman of Carnegie Brothers & Company, Managing Director of Carnegie, Phipps & Company, and President of the Carnegie Natural Gas Company. As may be supposed, he was a very active and busy man, and his time was fully employed. His death was entirely unexpected, although he had not been in full health recently and was making arrangements to take a trip to California for that reason. Mr. Stewart was a cousin of the late Thomas A. Scott, and was intimately connected with him in business. He leaves a large fortune to his wife and three children, who survive him.

WILLIAM R. DAVENPORT died very suddenly in Erie, Pa., December 13, aged 57 years. He was born at Watkins' Glen, N. Y., but when still a child removed with his parents to Erie, where he passed the remainder of his life. At the age of 15 he began business life as a clerk in a store in that town, and some years later was clerk and afterward station agent of the Cleveland, Painesville & Ashtabula Railroad. In 1866, with Mr. John Fairbairn and Mr. William A. Galbraith, he commenced the manufacture of car wheels, and two years later added car works on a small scale. From these small beginnings gradually grew the extensive establishments known as the Erie Car Works

and the Car-Wheel Works of Davenport, Fairbairn & Company, and their success was largely due to Mr. Davenport's energy and ability. In 1881 the business of the firm was so far extended that they decided to manufacture their own car-wheel iron, and built the Martel Furnace at St. Ignace, Mich. Mr. Davenport acquired considerable property, and leaves a valuable estate. He was interested in several other companies as a stockholder. He was prominent in church and benevolent matters, and was always a liberal giver for such objects. He leaves a widow, one son, and three daughters. His son, Mr. Charles W. Davenport, has been associated with him in business for several years. He was highly respected by his friends and neighbors, and, indeed, by all with whom he came in contact, for his uprightness, ability, and public spirit.

LUCIEN GAULARD, who died in Paris, France, November 26, was born in 1850, and was well known in French and English scientific circles. His name is associated principally with the system of electrical distribution by secondary generators, which occupied his sole attention during the last six or seven years; his earlier efforts were devoted to various branches of electrical and chemical science. In 1881 M. Gaulard showed at the Electrical Exhibition in Paris his thermo-electric battery, which excited a great deal of attention. It was at this time that M. Gaulard was invited by Mr. Gibbs to come to London, and since then, up to the time of M. Gaulard's illness in the spring of the present year, he was a director of the National Company for the Distribution of Electricity by Secondary Generators (Limited). M. Gaulard was a member of the Society of Telegraph Engineers, and was decorated by the King of Italy at the Turin Exhibition in 1884. He leaves a widow but no family.

The London *Electrician* says: "The history of invention scarcely contains a more mournful story than that of M. Gaulard. To him, beyond all question, belongs the honor of having initiated one of the most brilliant and successful developments of electrical engineering. . . . By a most unhappy fate, M. Gaulard contrived just to miss the one point of detail in the method of using his apparatus which involved the difference between commercial success and practical failure. Having thus missed his way, he had, in consequence, to suffer the mortification of standing idly by while other men were eagerly pursuing the track upon which he first set out. But though it is impossible not to feel the deepest sympathy for the unfortunate position in which M. Gaulard was placed, we believe it to be equally impossible to cast the blame of his misfortunes upon other shoulders. In actual life every man must abide the fortune of war with such fortitude as his individual temperament may permit. Unhappily, in this case, the strain proved at length to be greater than the mental equilibrium of the inventor could sustain. And notwithstanding the gleam of sunshine which the purchase of the American patent by the Westinghouse Company must have brought, yet in the early part of last summer his intellect became clouded, and it was found necessary to place him under restraint."

PERSONALS.

CAMPBELL WALLACE has been reappointed Railroad Commissioner of Georgia for a second term of six years.

JOHN MCLEOD, Chief Engineer of the Louisville Southern Railroad, has been appointed General Manager of that road.

R. L. VAN SANT is now Chief Engineer of the Indianapolis, Decatur & Springfield Railroad.

W. B. HANLON has been appointed Chief Engineer of the Cleveland, Lorain & Wheeling Railroad.

S. R. PATTERSON is Chief Engineer of the Kansas City, Fort Smith & Southern Railroad.

O. F. BALSTON has been appointed Chief Engineer of the Kings County Elevated Railroad in place of ANDREW BRYSON, resigned.

F. I. CABLE has been appointed Assistant Engineer of the Chesapeake & Ohio Railroad, with special charge of new bridge construction.

JOHN S. WILSON, late General Traffic Agent of the Pennsylvania Railroad, has been chosen President of the Poughkeepsie Bridge Company.

R. M. RICHARDSON has resigned his position as Master Mechanic of the St. Louis, Iron Mountain & Southern Railroad, after 22 years' service on the road.

GENERAL JOHN NEWTON has resigned the position of Commissioner of Public Works of New York City, to devote his time to his private business interests.

J. T. HARAHAN has resigned his office as General Manager of the Louisville & Nashville Railroad, to accept the position of Assistant General Manager of the Lake Shore & Michigan Southern.

CHARLES P. COLEMAN has been appointed Chemist of the Lehigh Valley Railroad, with office at South Bethlehem, Pa. He will have entire charge of the supply of oils, tallow, and similar articles, in addition to other duties.

SAMUEL SPENCER retires from the position of President of the Baltimore & Ohio Railroad Company after a term of very active service. He is succeeded by CHARLES F. MAYER, of Baltimore, for some time past President of the Consolidation Coal Company. Mr. Spencer's retirement is due entirely to changes in stock interests.

NOTES AND NEWS.

The Williamson Technical School.—A technical school on an extensive scale for instructing boys in various trades is to be established under a donation made by Isaiah V. Williamson, of Philadelphia. The fund given by Mr. Williamson consists of securities amounting to $1,536,000, and under the deed of trust these securities are to be appraised and then divided as nearly as possible into two parts. One-fifth is to be composed of securities which are easily and advantageously salable, and will constitute the building fund. The remaining four-fifths will go to the endowment fund.

The object which Mr. Williamson has in view is to train young men to mechanical trades, so that they may earn their own living, and every student who enters the school will be compelled to learn thoroughly one good mechanical trade. Their general and moral instruction is also provided for.

A New Petroleum Yacht Engine.—The recent launching of John A. Secor's yacht *Eureka*, in Brooklyn, N. Y., which is to be propelled by his system of atomized petroleum exploded by electricity, was a subject of much interest to scientists and engineers.

The motive power is applied directly to the water through pipes at the bow and stern, and is the expansive or elastic properties of oil gas, which is injected into the cylinder in the form of spray, and is suddenly converted into gas by electricity. The cylinder is 10 ft. long and 20 in. in diameter, and is placed just below and parallel with the surface of the water. The oil-tank is surrounded with a jacket of water, and is so constructed that only the malicious boring of a hole in it could bring about the possibility of an explosion. The cylinder is constructed to stand a strain 50 times as great as is produced by the heaviest possible explosion of the atomized petroleum. The machine is automatic except for the small amount of electricity needed to explode the gas. The forward pipe, which is provided, is to be used for backing and stopping the vessel.

The Burning of the "Maryland."—The transfer steamer *Maryland*, which was used for conveying passengers from the Pennsylvania Railroad station at Jersey City to the New Haven frieght station at the Harlem River, was burned on the evening of December 7 just as she reached her dock. The boat was a total loss, and the four cars on board, belonging to the Boston Express, which leaves Washington at 2.30 P.M., were burned down to the running gear.

The *Maryland* was built in 1852 for the ferry across the Susquehanna from Perryville to Havre de Grace, on the Philadelphia, Wilmington & Baltimore Railroad, and was the first steamer used for transferring trains on tracks laid upon the deck. During the war she was used on Chesapeake Bay for transporting troops by General Butler, but resumed her place until the bridge at Havre de Grace was built; from that time to 1875 she was laid up, but soon afterward was purchased by President C. P. Clark, of the New York & New England Railroad, and rebuilt in her present form. She was then brought to New York, arriving there May 1, 1876, commenced to transfer first passenger trains then first run through between Washington and Boston, and she was the originator of the link in railroad connection between the Pennsylvania, the New York, New Haven & Hartford, and the New York & New England roads. The *Maryland* was a notable boat in her time, and was an object of much curiosity and interest when she first began her trips across the Susquehanna.

New English Steamers.—In the yard of Caird & Company at Greenock, Scotland, there has just been completed a new steamer called the *Peninsular*, for the Peninsular & Oriental Steamship Company, and the *Oriental*, a sister vessel, is nearly ready for launching. These ships are 410 ft. long, 48 ft. beam,

and 36 ft. deep, their gross tonnage being 5,500 tons; the loaded draught is 25 ft., the displacement 9,000 tons, and the dead-weight carrying capacity about 4,000 tons. They are built of Siemens steel, with four steel decks, the upper deck being strengthened for gun platforms, in accordance with Naval Reserve requirements. They are divided by eight water-tight bulkheads, all extending to the spar deck.

These ships will carry 180 first-class and 32 second-class passengers. Very handsome saloons, staterooms, and other accommodations are provided. They will be lighted throughout by electric lights, and will each be provided with two search-lights, for use in passing through the Suez Canal.

The motive power consists of a triple-expansion engine, the cylinders being 38 in., 59½ in., and 96 in. diameter, with stroke of 66 in. Steam is supplied from three double-ended and two single-ended boilers, having in all 24 furnaces, and the working pressure carried will be 150 lbs. It is expected that the sea speed will be about 16 knots an hour. They are provided with steam steering gear and with special machinery for ventilation.

The St. Clair River Tunnel.—Work has been begun on this tunnel, which is to extend under the St. Clair River from Sarnia, Ontario, to Port Huron, Mich. There will be no intermediate shafts; the tunnel will be worked entirely from two portals. Its total length will be 4,620 ft., about 2,400 ft. being under the river, which has there an extreme depth of 42 ft. The roof of the tunnel will be about 25 ft. below the river-bed; the material through which it is to be driven is a tenacious blue clay. The tunnel will have a circular section of 20 ft. 4 in. outside and 19 ft. 10 in. inside, and will be lined with cast-iron segments, which are made 18 in. wide and 2 in. thick, and are provided with 6-in. flanges, by which they are bolted together. Fourteen segments, with a key piece 10 by 18 in., complete a circle. The tunnel will be driven through the clay by hydraulic pressure, a cast-steel shield 5 ft. by 21 ft. and 4 in. thick being forced forward into the clay by 24 hydraulic jacks, which together exercise a pressure of about 3,000 tons. Air will be supplied to the tunnel by two 30 H.-P. blowers, and it will be lighted, while the work is going on, with electric lights. The cost of the tunnel, it is expected, will be over $2,000,000.

A California Dam.—The Folsom Dam, which is now being constructed across the American River above the California State Prison, for the purpose of furnishing motive power to the prison and innumerable manufacturing industries, is a work of some importance.

The concrete foundation beneath the solid masonry has an average depth of 4 ft., but on the lower side of the dam it is much greater by reason of the downward pitch of the bedrock. The width of base of the structure on the bedrock is 61 ft., and will be 25 ft. on top when completed. The height of the structure at the present time is 20 ft. 6 in., and when completed will be 69 ft. The entire length of the dam will be 469 ft. Of this 218 ft. is the tangent, or portion extending directly across the river; 121 ft. of curve, by which the water will be turned to the State Prison side of the river, and 130 ft. of wing for conducting the water to the canal. It is estimated that about one-sixth of the masonry work of the entire structure is now completed, but considering the great difficulty in controlling the flow of the river, and in getting the foundation laid, much more than that proportion of the work is done.

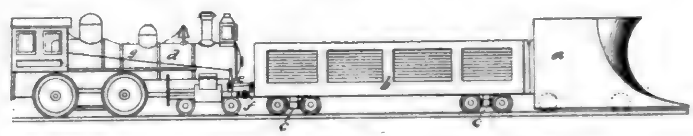
The temporary dam for turning the water from the bed of the river through a flume was completed in September, but the laying of stone was practically commenced on October 1. From that date to November 15 about 90,000 cubic feet of granite was laid.

New French Steamships.—A steamer named the *Paraguay* has been launched at St. Nazaire for the Compagnie des Chargeurs Réunis. The *Paraguay* is 379 ft. long, and has a carrying capacity of 2,200 tons. She will be fitted with engines working up to 1,900 H.P., and she is expected to attain a speed of 13 knots per hour. She will have accommodation for 60 first-class passengers, 40 second-class passengers, and 600 third-class passengers. The steamer *Battambarg*, built for the Compagnie Messageries Fluviales de Cochin-Chine, has just been launched at Nantes. The *Battambarg* is 197½ ft. long, and has a carrying capacity of 400 tons. She is fitted with engines working up to 680 H.P., and she attained on her trial trip a speed of 12 knots per hour. The *Guadiana*, a vessel of 2,570 tons, built for the Messageries Maritimes, has been launched at Havre. The *Guadiana* is 351 ft. long, her engines work up to 1,500 H.P., and she is expected to attain a speed of 13 knots per hour. She will carry 36 cabin passengers. A small steamer, 113½ ft. long, and named the *Wangpoo*, has been launched at Shanghai; she was built for the Messageries Maritimes, and will be employed by that company on the Yang-Tsé. The *Eugène Pereire*, just completed at St. Nazaire, has left that port for Marseilles, and will run between Marseilles and Algiers; she is 356 ft. long by 35¼ ft. beam, and 29 ft. deep. She is fitted with triple-expansion engines working up to 2,000 H.P., and she attained a speed of 17 knots per hour upon her trial trip. She will carry 200 first-class and 50 third-class passengers, and she is expected to prove herself the swiftest steamer engaged in the Mediterranean trade.

Cornell University.—The recently issued catalogue says: "The Mechanical Laboratory, which is the department of demonstration and experimental research of Sibley College, and in which not only instruction but investigation is conducted, is located in the annex of Sibley College, in several rooms of good height, well lighted on all sides, and carefully fitted up for the purpose for which they are designed. It occupies the whole lower floor, a space 150 ft. long by 40 ft. wide, and represents the latest contributions of Mr. Sibley to the University. It is supplied with the apparatus of experimental work in the determination of the power and efficiency of the several motors, including steam engines, and the turbine driving the machinery of the establishment; with boiler-testing plant and instruments, and with a number of machines for testing lubricants and the strength of metals. Among these is the autographic testing machine, which produces an autographic record of the results of the test of any metal which may be placed within its jaws, securing exact measures of the strength, the ductility, the elasticity, the resilience or shock-resisting power, the elastic limit, etc., of the material. Several steam-engines and boilers, air and gas-engines, several kinds of dynamometers, lubricant-testing machines, standard pressure-gauges, and other apparatus and instruments of precision employed by the engineer in such researches as he is called upon, in the course of his professional work, to make, are all collected here."

A Snow-Plow Battering Ram.—An inventor, who has apparently been studying the ancient battering ram, has recently taken out a patent for "improvements in the art of forcing snow-plows through snow-drifts," his invention consisting of the use of a weighted car, or battering ram on wheels, by which the snow-plow is to be pounded into or through a bank. The accompanying engraving will show his method; in it *a* is the snow-plow, *b* a car body mounted on the trucks *c* and loaded as heavily as their strength will permit, and *d* the engine. There is added to the engine a bell-crank lever, *e*, one arm of which is connected with the coupling-pin and the other with the rod *g*, extending to the cab, so that the engine can be coupled to or uncoupled from the car *b* while in motion. The operation of his device is as follows:

"When the plow *a* becomes stuck in a drift or bank, so that the engine cannot crowd or push it therethrough, the engine will be coupled with the car or body *b*, and the latter, discon-



nected from the plow *a*, will be drawn back a suitable distance and run forward at great speed until it approaches near to the plow *a*, when the engine, if not previously disconnected from the body *b*, will be uncoupled therefrom and reversed. With this operation the body *b* will by its own momentum be carried forward with great force against the plow, driving it into or through the drift or bank, while the momentum of the engine will have been overcome, or so far overcome by the reversing of the same as to receive an inconsequential amount of the impact or shock. In case the plow should not be driven through the bank or drift the operation just described may be repeated until it is forced to a point where the engine or engines may be able to push it steadily ahead."

The inventor says that the form or construction of the plow or engine is not of importance. An impartial observer will probably coincide with this view, and will also be inclined to doubt whether the plow—possibly the engine also—will have much form of any kind after the device has been in operation for a short time.

The inventor of this arrangement is John Byfield, of Chelmsford, Mass., and his patent is No. 392,905.

A New Draftsman's Scale.—At a recent meeting of the Engineers' Club of Philadelphia, Mr. L. F. Rondinella exhibited a "Scale of Proportionate Inches," designed especially for the use of mechanical engineers and machine draftsmen. The civil engineer has his scale of feet or inches divided decimally; the architect his scale of *proportional feet* where the unit (¾ in., 1 in., 1½ in., etc.) represents one foot and is divided into 12 parts for inches. But the mechanical engineer, though working almost exclusively in inches in his designs, has been obliged heretofore to use the architect's scale, transforming each

size from *inches* to *feet and inches* before laying it down on his drawing, with considerable loss of time and liability to error; while the scale that is perhaps most used by machine draftsmen —half size—is entirely absent from the architect's scale as usually made.

The scale of proportional inches contains the scales that are most used in practice—full size, half size, quarter size, and eighth size—in *inches*. The divisions are arranged as in the architect's scale, two scales on each edge, the unit outside of the zero point being subdivided in the larger sizes to sixteenths, in the smaller sizes to eighths. The graduations are United States Standard, engine-divided, and the scale is furnished in bristol-board or boxwood.

The Chilian Railroad Contract.—The Chilian Government has made a contract with Newton B. Lord, representing the North & South American Construction Company, an American organization, to build about 600 miles of railroad during a term extending over about five years. The lines to be built, with the contract prices, are as follows:

1. Calera to La Ligua and Cabildo, 76 kilometers, $1,650,000.
2. Huasco to Vallenar, 48 kilometers, $425,000.
3. Ovalle to San Marcos, 60 kilometers, $800,000.
4. Los Vilos to Illapel and Salamanca, 128 kilometers, $1,260,000.
5. Constitucion to Talca, 85 kilometers, $1,425,000.

The above lines are all to be narrow gauge—1 meter. Those named below are to be of the Chilian standard gauge—1.68 meters, or 5 ft. 6 in.:

6. Santiago to Melipilla, 59 kilometers, $1,050,000.
7. Pelequen to Puemo, 28 kilometers, $550,000.
8. Palmilla to Alcones, 45 kilometers, $600,000.
9. Coihue to Mulcheno, 43 kilometers, $625,000.
10. Vittoria to Valdivia and Osomo, 403 kilometers, $9,325,000.

This is a total of 578 kilometers of standard and 397 of meter-gauge, making 975 kilometers (607 miles) in all. The roads are to be completely equipped. The bridges are to be of iron of the American system. The final locations are to be subject to Government revision, and the conditions of the contract are very strict.

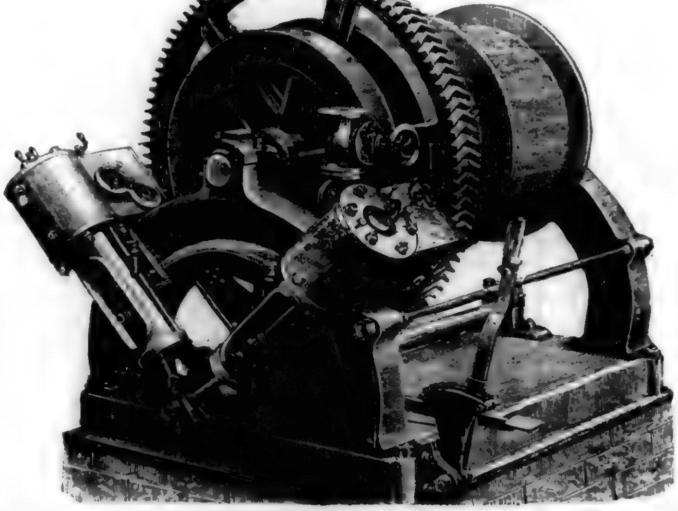
Project for the Storage of Nile Floods.—Owing to the extremely low Nile of this year the sanitary condition of Cairo is very unsatisfactory, and particular attention has been called to Mr. Cope Whitehouse's project for storing the flood-waters of the high Nile, in a natural depression of the ground southwest of the Fayoum District. At present the water is kept out from the district by the Mayana dam, formed of desert land, and dividing the Bahr Yusuf Canal from the Fayoum District, which embraces an area of about 1,000 square miles, a portion of which is now a brackish lake. The volume of water flowing down to the Delta at high Nile is about 40 times that of low Nile, and a treble quantity of low Nile is sufficient for the supply of Cairo and neighborhood. During high Nile there is therefore a great waste of water, and Mr. Whitehouse proposes to store some of the excess in a natural reservoir called the Raiyan Moeris, situated 75 miles from Cairo. By cutting a canal from the Nile through the dam above mentioned, and continuing it westward till this basin is reached, the latter could be filled at high Nile to 30 meters above sea level, and would then form a fresh water lake 250 square miles in area, and would contain over 20,000,000,000 tons of water. The actual storage required for the irrigation of the 2,500,000 acres of land, which could be reclaimed and made valuable in this way, is, however, only 2,500,000,000 tons. It would require one season to fill the small basins and three seasons to fill the whole reservoir. The total cost of the work is estimated at $1,750,000. The work would, in effect, form a reservoir in which the surplus of a wet year could be stored up and saved for use in a dry season.

The First Locomotive Cab.—Mr. E. E. Duncan, who is now a resident of Detroit, and who can claim to be one of the oldest locomotive engineers now living, writes that he began railroad work on the old New Jersey Railroad, April 1, 1836. For nearly two years afterward the road was operated between Jersey City and Newark by horse power. After serving an apprenticeship of three years in the shop he went on the road as a locomotive engineer, continuing in that position for somewhat over 25 years.

Mr. Duncan says that the first cab put on a locomotive to his knowledge was in 1838, when the then Master Mechanic of the New Jersey Railroad fitted one on the locomotive *Newark*, which was a Rogers engine, with a single pair of drivers. It was a primitive affair, consisting of a wooden front and a roof, with glass windows, 8 by 10 in. in size, in front to look through, and fitted at the side with leather curtains, which were rolled up like carriage curtains. This improvement attracted considerable attention, and Mr. Thomas Rogers came down from Paterson to look at it; he approved of the idea wholly, and a short time afterward he designed and put on a locomotive built in his shop the first permanent cab, and from that time on the cab was a regular part of the locomotive.

Mr. Duncan claims to have made very fast time during his service on the New Jersey Railroad. In 1852, he writes, when the telegraph was still new, he was asked by the Superintendent of the road if it would be possible to get the President's message through to New York by train in quicker time than it could be telegraphed by the slow methods of those days. The message was sent through by special engine, and Mr. Duncan ran his part of the trip, from New Brunswick to Jersey City, 31 miles, in 33 minutes. The engine with which this time was made was the old *Jersey City*, a Rogers engine having a single pair of 5-ft. drivers, an ordinary truck forward, and a single pair of bearing wheels behind the fire-box. This was the last Presidential message carried to New York by rail, as improvements in the telegraph made shortly afterward increased the speed of transmission so much that competition was hopeless.

A German Hoisting Engine.—The accompanying illustration, taken from *Glaser's Annalen*, shows a hoisting engine driven by compressed air, which has lately been put up by the Prince Rudolph Mining Company at Dulmen, Westphalia. The entire machine is mounted on a bed-plate cast in one piece, and is so arranged that it can easily be moved if necessary. On the bed-plate are bolted two arched standards which carry at the top the boxes in which the shaft of the hoisting drum revolves. On one of these standards the two cylinders are bolted, placed at right angles to each other and at an angle of 45° with the bed-plate. The guides are cast with the cylinder-head as shown, and are bored out, the cross-head having a circular form. Both connecting-rods work on a crank attached to a shaft which runs in two bearings bolted to the bed-plate. This shaft carries a pinion with spiral teeth which works in a large gear wheel fixed on the shaft carrying the hoisting drum. The crank shaft carries two eccentrics which serve to work the valves of both cylinders through an ordinary link motion. The



lever for stopping, starting, and reversing the engines is placed in front, as shown, on a bracket bolted to the bed-plate.

The hoisting drum is of cast iron lagged with oak. On the main shaft there is also a heavy wheel to which a brake can be applied through the foot lever shown in the engraving. The brake-shoe is of iron faced with oak. The two standards are braced and held together by two heavy bolts placed at the level of the lower end of the cylinders.

The cylinders are 170 mm. (6.7 in.) diameter and 160 mm. (6.3 in.) stroke. The driving pinion is in proportion to the large wheel as 1 : 6. The usual working pressure of compressed air is four atmospheres, and with this pressure the engine can lift 400 kilos. at the rate of 1 meter per minute. The hoisting drum is 800 mm. (31.5 in.) diameter. The whole machine takes a floor space of 3.5 square meters (37.7 square feet), and the total height from the bottom of the bed-plate is 1.950 meters (6 ft. 5 in.).

Several of these machines have been at work for some time with very good results. The advantages of compressed air over steam for working such an engine in mines or other places where the ventilation is poor and the heat great are too well known to need repetition. There is also a special advantage in the use of compressed air where steam would have to be carried a long distance through pipes, causing much loss by condensation.

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NEW YORK, FEBRUARY, 1889.

IN spite of the continued extension of the use of iron and steel in bridges and other structures, wood must continue to play a very important part in our railroads and other engineering works. Wooden trestles and wooden bridges will continue very largely in use until timber becomes very much scarcer and more expensive in this country than it now is, while on highway roads the great majority of the smaller bridges will continue to be of wood for many years to come. Culverts, cattle-guards, and other structures of wood, aside from bridges, are and will remain in extensive use, and every engineer in active service knows how necessary a knowledge of the principles governing such structures is to the proper performance of his duties. In too many cases the wood-work on our railroads is considered a mere carpenter's job, and is left to be worked out by rule of thumb, or by following old and often faulty precedents, either because the engineer has not time to attend to it, or because he has not the necessary instruction.

Under these circumstances it is believed that the series of articles begun in another column on Wooden Structures will be both of interest and value to engineers and others. Their object is not so much to present anything absolutely new as to formulate and make accessible the most approved practice with regard to such structures, and the principles which should govern generally the use of wood in engineering. They will be fully illustrated as the subject requires, and accompanied by definite and practical directions as well as by full descriptions.

THE subject of highway roads is attracting some attention just now, and in two States—New Jersey and Pennsylvania—the Governors have called legislative attention to the necessity of improvement. In most of our States the regulation of roads has been left to towns and local authorities, and has been in very incompetent hands, so that the work done on them has been either neglected or in a large part wasted. The favorite plan at present seems to be a change of control from township to county authorities, giving the road superintendent a wider field to work in, and an opportunity to adopt comprehensive plans; also permitting the employment of more competent persons as overseers.

A step which promises good results has been taken by Vanderbilt University, at Nashville, Tenn., where the Engineering Department has offered to admit free of charge to its class in road engineering, one highway officer from each county in the State. The course of instruction, which is given in the winter months, consists of lectures and work on the location of roads; the principles of construction and maintenance; methods of drainage and similar matters, and is intended to be as practical as possible. This is a move in the right direction, and if the County Board and local officers can be persuaded to co-operate will doubtless produce excellent results.

THE Poughkeepsie Bridge is now very nearly completed, and the first train passed over it December 29. The bridge proper and its approaches can be made ready for regular traffic in a very few days, and it now only waits the completion of its connecting lines to come into full use. The line west of the river has still two or three months' work to be done upon it. East of the river one connection is already made, but there is still a great deal of work to be done on the line to Brewsters, from which most of the bridge traffic is expected to come. It will probably be summer before the bridge can be considered as fully opened.

ANOTHER notable bridge structure now nearly completed is the new Manhattan Bridge over the Harlem River in the upper part of New York City. This is a road or street bridge crossing the deep valley through which the river flows at that point on two steel arches of 525 ft. span, the approaches on each side consisting of stone arched viaducts. It is a very handsome structure, and rivals in appearance the famous High Bridge a short distance from it.

THE output of steel rails in 1888 fell off nearly one-third from those of 1887, the total reported last year having been 1,528,057 tons against 2,290,197 in 1887. It must be remembered, however, that 1887 was an exceptionally prosperous year, when some 13,000 miles of new railroad were built, or almost twice as much as last year. The difference in new construction will account for the falling off in sales, and it is probable that the regular demand for renewals was fully as great, if not greater last year than in 1887. This is, after all, the demand upon which the mills have to rely for a steady business, and that it should be well kept up is an encouraging feature of the trade.

NEW railroad construction in 1888, as reported by the *Railway Age*, amounted to 7,120 miles, or a little over one-half that of 1887, a result somewhat greater than might have been anticipated from the course of events early in the year. A considerable part of the work done was on lines begun in 1887, and in completion of systems marked out in that year, and a very large proportion of it was done by old companies. The total number of lines or branches on which track was laid was 365. A large num-

ber of these were short, very few long roads or extensions being included in the list, and hardly any which can be considered as through or trunk lines.

The Southern States led in the increase, reporting 2,074 miles, or nearly 30 per cent. of the total. The Southwest followed, with 1,675 miles, or about 23 per cent. The Pacific Coast, with 1,055 miles, and the Central Western States (Ohio to Illinois, inclusive), with 1,030 miles, were nearly even, while the Northwest reports only 834 miles, the Middle States, 270, and New England, 182 miles. The greatest mileage built in any one State was 601 miles in Kansas, California coming second with 560, Georgia third with 452, and Kentucky fourth with 353 miles.

It is notable that the building of new through lines, and especially of competing lines, which stopped some time ago in the East, has almost come to an end in the Northwest. A good deal of this kind of work was done in the Southwest last year, but mainly in the execution of plans already made, and it is safe to say that still less will be done this year by the companies which are now suffering from the results of over-competition.

The new work in the South has been of an excellent kind, chiefly of short lines intended to develop local business. Very much of it has been done with special reference to the mineral resources of that section, which are now attracting so much attention.

The present prospects are that while 1889 will be rather an off year for new railroad construction, there will be a fair amount built, chiefly in short local lines and branches.

THE latest attempt to counteract the losses and evils resulting from over-building and over-competition has taken the form of an agreement adopted at a meeting, at which were present a large number of railroad officers and bankers interested in railroads. At this meeting a plan of organization was adopted for an Interstate Commerce Railroad Association, the object of which is the regulation of rates ; the prevention of undue competition ; the enforcement of the Interstate Commerce Law, and the settlement of disputes by arbitration. The agreement has many excellent points, and should produce a good effect. It has, however, the same drawback which has attended all previous agreements, and that is, that there is no possible method of enforcing its observance, and that it depends entirely upon the good faith of the railroad officers, who are the contracting parties.

Unfortunately, past experience shows that this is a very doubtful guarantee, and that, however high the individual character of a railroad officer may be, his corporate action is not to be relied upon. A reform in this respect is most urgently needed, and it is to be hoped that the new agreement may be a beginning in this direction.

THE New York Railroad Commission has submitted its annual recommendations to the Legislature in the form of 10 bills, which have been presented in the Senate. The first gives the Commission power to enforce its recommendations by an appeal to the Supreme Court. The second provides for the gradual abolition of highway grade crossings. The third is a general law regulating the leasing of roads. The fourth prohibits the leasing of parallel or competing lines. The fifth prohibits rebates or discrimination in rates. The sixth bill imposes a fine for failure to make annual reports. The seventh specifies the limit and degree of liability for fire resulting from locomotive sparks, on property adjoining a railroad line. The eighth requires railroad companies to place railings on the sides of every freight car, while the ninth provides for the substitution of some approved form of rail for the center-bearing rail now in use on street railroads.

These are all renewals of recommendations made to the Legislature last year ; the only new bill which the Commission presents is the tenth, which requires railroad companies to place a thermometer in every passenger car, and to maintain the temperature of each car at at least 70 degrees. The Legislature has not heretofore paid very much attention to the recommendations of the Commission, its bills having gone over year after year without action, probably because they have had no special political backing. It is to be hoped that some of them at least will receive this year the attention which they deserve.

THE bill to incorporate the Maritime Canal Company of Nicaragua has passed the House of Representatives, but its opponents succeeded in securing the adoption of several amendments, so that it has to go back to the Senate, where it originated, and its final form will probably be settled by a conference committee. There is no reason why it should not pass, and the only cause for its failure will be the hurry which always marks the end of a short session of Congress. The principal amendments made were intended to prevent any possible application of the Company for a guarantee of its securities by the Government, but this should make little difference, as we do not understand that any such action is or was contemplated.

Meantime it is understood that this delay will not cause any trouble, as, under its present organization, the Company has made provisions for continuing preliminary work on the Canal, and for the commencement of actual construction within the time required by the Nicaragua concession. The present prospects are very good for commencement of actual work, and for the completion of the Canal within a reasonable time.

THE Secretary of the Navy has issued an order directing that the Naval War College be discontinued as a separate institution, and consolidated with the Torpedo School. This order will require a considerable change in the plans for carrying on the College, but does not, it is understood, imply the entire discontinuance of the very useful course of instruction which it was intended to furnish.

ELECTRICITY plays an important part in the modern war vessel ; not only is it used for lighting, but it is now also applied in several ingenious forms for firing guns and for determining the range and direction of the shots. The latest application is in the use of an electric motor for hoisting shot and shell from the magazine below to the level of the guns, and for loading the guns themselves. This apparatus is the invention of Lieutenant Bradley A. Fiske, and is so arranged as to prevent any possible accident resulting from the wounding or death of the gunner. This provides for all contingencies, besides reducing the number of men required to handle a large gun ; a very important point where guns are mounted, as is the case in most armored ships, in turrets or barbettes where the space is very limited.

THE recent change in the Russian Ministry of Railroads is, apparently, to be followed by the adoption of an active policy of improvement and extension. The first signs of this will be a large increase in the equipment of the Government railroads, and already orders have been given out for 90 new locomotives, which are to be built in Russia, while it is announced that 230 more are shortly to be ordered. It is also stated that the Russian railroad system is to be improved and extended by the building of several important branches and connecting lines, surveys for which were made some time ago, but whose construction has been postponed from time to time.

It is understood also that a part of the new policy is the active beginning of construction on the Siberian Pacific Railroad, of which mention has already been made in our columns, and which is likely to be an important line from a commercial point of view. In fact, nearly all the new lines projected will be of importance commercially, as most of them are intended to give increased facilities of transportation to the wheat-growing districts and to enable them to compete more actively with those of other countries in the European market. Possibly the Russian Government has been led to adopt this policy from the fact that the British Government is now engaged in carrying out a similar plan for the development of the wheat districts of India, so that that country is every year becoming a more formidable competitor of Russia—and of the United States also—in the grain markets of Europe.

A considerable sum is to be devoted to the improvement and extension of the Trans-Caspian Line. Those sections of the road which were at first slightly built are to be placed on a more permanent basis, the equipment is to be increased, the road is to be extended, and some branches built. On the Western end also the line will probably be extended from its present terminus at Azoun-Ada some 60 miles to Krasnovodsk, which is one of the best harbors on the Caspian Sea. All this indicates that it is the purpose of the Government to develop this road as a commercial line and to abandon the exclusively military character which it at first possessed.

FRANCE is not a country of large navigable rivers, but nevertheless its inland traffic by river and canal is of considerable importance. By the returns made to the Government for 1887 the total length of inland navigation was 16,644 kilometers, of which 12,720 kilometers were reported as much frequented. This length was made up as follows: Rivers floating only small boats, 1,012 kilometers; rivers naturally navigable, 3,340; rivers made navigable by artificial means (canalized), 3,579; canals, 4,789 kilometers. Since 1879 the length of navigable waters has been increased about 2,100 kilometers. Upon these waters there were employed last year 673 steamboats, the greater part being tugs, with a total tonnage of 45,865 tons, and 15,730 boats or barges with a total carrying capacity of 2,714,000 tons. The inland water-courses of France are thus of considerable importance to commerce, and although little is usually heard about them, they are valuable both as auxiliaries to and contemporaries of the railroads. While they do not compare in size or importance with our own internal water-ways, they are still an indispensable part of the traffic system of the country, and the Government wisely takes an active interest in their preservation and extension.

THE work on the ship canal which is intended to connect the Baltic with the North Sea, and which was begun at Kiel in June of last year, is now well advanced, the excavation having been completed for nearly 28 out of the 62 miles required. On the western end the new canal is finished to the junction with the old Eider Canal, and on the eastern or Baltic end about 13 miles are finished. This canal is entirely on German territory, and, like most German Government works, was undertaken largely with reference to its value in case of war, as it will furnish a connection between the German navy-yards and the naval stations on the Baltic and the North Sea, which can be defended without difficulty, and will enable German war vessels to avoid the stormy passage around Denmark and possibly conflict with a hostile fleet under unfavorable circumstances.

While this canal will be useful for commercial as well as for military purposes, it is proposed to make another one entirely on Danish territory, in order to be beyond German control. This canal will be some distance to the north of the German canal, crossing the peninsula of Jutland from the Bay of Jammer to the Limfjord. Surveys have been made for it, and the cost is estimated at about $40,000,000. It is said that the necessary capital has been subscribed by French and English parties, but this seems to be somewhat doubtful.

THE reports of the New York City railroads to the State Railroad Commission give the figures for their traffic for the year ending September 30 last, and enable us to make some comparisons with the previous year. The total number of passengers carried by the elevated roads and by the surface (horse) roads for the year was:

	1888.	1887.
Elevated lines	171,529,789	158,963,232
Surface lines	205,383,797	199,574,966
Total	376,913,586	358,538,198

The increase last year was thus 18,375,388, or a little over 5 per cent.—a decided falling off in the rate of gain from the preceding year, 1887 having shown an increase of 11½ per cent over 1886. The increase last year on the elevated lines was nearly 8 per cent., showing that those lines have received the benefit of nearly all the new travel, and that the movement of population far up-town continues, though in a somewhat diminished degree.

The gain on the surface railroads was nearly 3 per cent., but an examination of the figures in detail shows that this was due entirely to a remarkable increase on the cross-town lines. Nearly all the up-and-down-town lines, which come into competition with the elevated roads, show slight decreases in traffic.

The equipment of the elevated roads consisted of 291 locomotives and 921 cars, an average of 3.16 cars per engine. The surface roads report 2,133 cars and 13,586 horses—an average of 6.37 horses per car, without making allowance for the one cable road in operation, which would not materially change the average.

The number of accidents was small, the casualties including 27 persons killed and 187 injured. Of these 19 were killed and 140 hurt on the surface roads, mainly by being run over; the remainder, 8 killed and 47 injured, were on the elevated roads. The number of casualties was small in itself, and was considerably less than in 1887.

RAPID TRANSIT IN NEW YORK.

THE people and the papers in New York City are again in their annual paroxysm about rapid transit. The present elevated railroads are very much overcrowded, owing to the fact that they have a very large traffic, and that the companies owning them do not supply a sufficient number of trains during the busy hours of the day. They find it more profitable to crowd people like cattle into their cars than to run cars enough to give decent accommodation. They have also managed with great skill to produce the general impression that it is impossible to run more cars, and, consequently, the great imbecile public submits with much meekness, while the nickels flow into the coffers of the company in a never-ceasing stream, which increases daily in volume. It may be true that on the Third Avenue line the limit to the number of trains which can be run has been reached, but there is no reason apparent why they cannot run as many trains on the other lines as they do on the Third Avenue. The Sixth Avenue road is terribly overcrowded in the morning and the evening, and more trains are urgently needed. The company, however, regards the discomfort of the people with great equanimity, and never seems to have cars or engines enough. They find that it is profitable to make the public stand up, and stand the public must. At present it vents its dissatisfaction by clamoring for more facilities for rapid transit up and down Manhattan Island, which is very curiously hedged in by obstacles which make ingress and egress difficult. On the one side is the East and on the other the North River, both wide streams, with strong tidal currents and liable to obstruction by ice in winter, and with an enormous commerce which cannot be obstructed by bridges, and in the case of the East River with a soil underneath exceedingly difficult to tunnel. On the south there is Staten Island, which is unhealthy, and on the west the Jersey flats, equally so, and in other ways malodorous. Business is concentrated in New York, and the problem is to afford means for people to go to and from their business daily. A project for a tunnel under the East River is being actively pushed, and seems only to require the consent of the Board of Aldermen. Schemes for bridges over both rivers are heard of, and the tunnel under the North River bubbles up in the mud and silt periodically with more or less vigor.

In New York City the relative merits of underground, overhead, and open-cut roads have been discussed for more than half a century without thus far reaching any definite conclusion. Briefly, the arguments for and against them may be summed up as follows :

Underground railroads are damp, dark, and disagreeable. No other motor is now available for a fast and heavy traffic excepting steam locomotives, which means bad ventilation and general discomfort. It may be stated, generally, that people will not travel underground if they can do so above. It seems as though that long period of underground residence which is in store for all of us creates a natural aversion to being there while it is possible to be on the earth's surface or above it. An open-cut railroad is not practicable in our streets or avenues, excepting, perhaps, in some of the newer ones up-town, because they are not wide enough. To acquire property for building such a line would be enormously expensive, and an open road would also be liable to obstruction from snow. It would be necessary, too, to carry all cross streets over such a road on bridges. In traveling on it there would therefore be a constant and quick alternation from daylight to darkness, which would be excessively disagreeable. To elevated roads in the streets there is now a strong public sentiment opposed, owing to the injury to property and to the difficulty of getting redress from a powerful corporation. There remains, then, only an elevated or overhead railroad built through private property. This means, of course, the acquisition of the property for the right of way, which, of course, would be enormously costly. But the experience with the elevated railroads has shown that there is little difficulty in constructing or operating a line of road at a height varying from 20 to 40 ft. above the street. If, then, a road should be constructed through private property, at a height of 30 or 40 ft. above it, the space below it would still be available for various uses, and could be made to yield a revenue to its owners. It would be possible, too, to erect buildings two or perhaps more stories high on the property, whose walls would serve the twofold purpose of supporting the railroad and enclosing the space below. If these were made fire-proof they would answer for storage warehouses, workshops, and many other purposes for which the noise of the trains would be no objection. A company of good financial standing could borrow money at a low rate of interest, and the rental of the buildings would, at least in part, pay the cost of the property. The present building laws permit of the covering 65 per cent. of a lot with a building. If these structures were erected with strong front and rear and intermediate walls, they could carry the railroad, and the side walls would help to give stability to the whole structure. The streets would be crossed by continuous iron-plate girders supported on iron posts at the curbs and on the front walls of the building. Other girders, either continuous or not, would extend from the front to the rear wall, and still others would span the space between the rear walls on adjoining lots. The front, rear, and intermediate walls could be arched so as not to interfere with the uses of the building, and at the same time give adequate strength for supporting the railroad. When stations are required they could be located on the property below the road with ample waiting-rooms and conveniences for the public. The girders could be made of such a height as to come up to the window-sills of the cars. The lower part of the train would thus be hidden from view from below, but passengers could see into the street from the windows. Such a road would not be expensive to construct, would not occupy the streets excepting to cross them, and would injure adjoining property less than any other form of elevated road. It would give abundant light and air to those who travel on it, and would give altogether a much more agreeable way of traveling than either an underground or an open-cut road would.

FRENCH VIEWS OF THE PANAMA CANAL.

IN France, as is natural, a more hopeful view is taken of the situation of the Panama Canal than on this side of the water. The *Revue Scientifique* gives the following statement, which it claims to derive from official resources, of the present situation of the work done on the Canal.

The sea-level canal, as originally projected, has a total length from Colon to Panama of 74 kilometers, with a width of 22 meters at the bottom and 44 meters at water

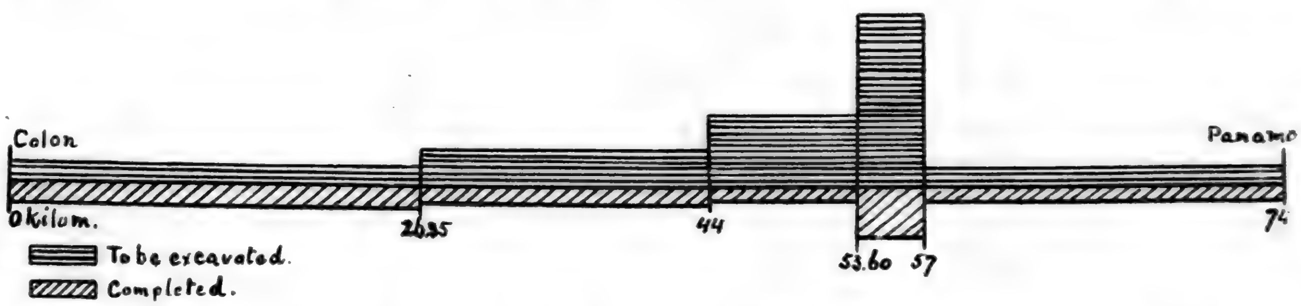
level. It was necessary to cut through hills of considerable size, which at certain points required the removal of a great mass of earth. It was in order to diminish in very large proportion this work that the Company has resolved upon the construction of a provisional canal, with locks having a lift of 38 meters, in this way raising the level of the canal by that amount for a long distance, and reducing the necessary amount of excavation by about 65,000,000 cubic meters. This canal with locks can be quickly made and put into use, and can then be producing revenue while the engineers are employed in the final completion of the sea-level canal.

The actual situation of the work at the present time is as follows: In the first division, extending from Colon to kilometer 26.35, there were in all 25,000,000 cubic meters of excavation, of which 19,000,000 have been completed.

In the second division, from kilometer 26.35 to kilometer 44, out of 24,000,000 cubic meters of excavation, 5,500,000 are completed.

In the third division, from kilometer 44 to kilometer 53.60, the difficulties are greater on account of the rocky nature of the country, and only 8,000,000 cubic meters out of 46,000,000 required are completed.

The fourth division, from kilometer 53.60 to kilometer 57, includes the great Culebra cut, in which are presented the most formidable obstacles to the work. This cut is through a schistous rock in horizontal strata, which slide one upon another in enormous masses. In spite of the many difficulties, it is believed that this problem will be solved, and it will only be necessary to employ men and machines enough to complete it. On this division 4,000,000 cubic meters have been taken out from the total of 27,000,000 required.



Finally, in the fifth division, from kilometer 57 to Panama, in which 14,000,000 cubic meters of excavation were required, the work is a little over one-half done.

The accompanying diagram shows in graphic form the state of the work, the lower portion, cross-sectioned, indicating the completed work on each section, while the upper portion, with heavy black lines, shows the amount still to be done.

The work on the iron locks, the contract for which has been let to M. Eiffel, is well advanced. The excavation for the locks has made considerable progress, while nearly 7,000 tons of iron for the locks and gates have been already completed, and the work is progressing actively in the shops of the Compagnie de la Loire at Nantes.

This is undoubtedly the best statement that can be made for the Canal, and it will be seen that the *Revue* takes no account of the collateral works necessary for the regulation of the Chagres River, which competent engineers believe to be the most difficult problem connected with the Canal. Even on its own statement, the amount of excavation required is still very formidable, while the most difficult portions of the work are hardly touched as yet.

The *Economiste Français*, which has stood almost alone among the French papers in criticising sharply the financial methods of the Company, thinks that the only solution of the problem possible now is the organization of a new company with a capital of not less than $50,000,000 and the surrender of the rights of the present bondholders, at least for a time. The subscriptions to the stock of the new company would enable it to continue the work with some prospect of completing it as a lock canal within three or four years. The problems—both engineering and financial—presented are, however, difficult enough to make even the warmest friends of the canal doubtful of their speedy solution.

NEW PUBLICATIONS.

NOTES ON MILITARY SCIENCE AND THE ART OF WAR: BY JOSEPH M. CALIFF, FIRST LIEUTENANT THIRD U. S. ARTILLERY, PROFESSOR OF MILITARY SCIENCE AND TACTICS, STATE UNIVERSITY OF IOWA. Cleveland, O.; The Borrows Brothers Company (price, $1).

This book gives in as brief and concise a form as possible the principles of the Military Art; it shows how the methods of handling men have changed from the time when they were assembled in heavy immobile masses, through the various changes of tactics down to the thin skirmish line of to-day; it also gives the organization of armies and their management; in short, in a concise but clear manner it shows how the game of war is conducted.

In addition to this, it gives the latest data regarding modern arms and military material—guns, projectiles, explosives, and torpedoes.

It is not a book for the professional soldier, as it gives only the framework and salient points of the subjects treated, such information as it is desirable to give to college students under military instruction, and which as educated men they should possess, or such as would be appreciated by any one interested in military affairs, but without the advantages of a military library or the time to give to a more serious study of the subject.

The total absence of any text-book on this subject renders it of especial value to all schools and colleges having a course in Military Instruction.

GEOLOGICAL SURVEY OF NEW JERSEY: FINAL REPORT OF THE STATE GEOLOGIST. VOLUME I.: TOPOGRAPHY, MAGNETISM, CLIMATE. Trenton, N. J.; State Printers.

The Geological Survey of New Jersey has always held high rank among similar works in this country for the excellence of its methods and the thoroughness with which its work has been done. It is now approaching completion, and Professor George H. Cook, the State Geologist, submits in the present volume the first part of his final report, which covers the topics given above.

Partial surveys were made in 1836–40 and in 1854–56, but the present survey was not begun until 1864. Its scope was gradually enlarged, until it reached the complete form which is indicated by the final report. It has been fortunate in two ways, in which some State surveys have

suffered—it has been continuously under the direction of the same competent head, and it has had steady support from the Legislature, so that the work could be carried on continuously and without breaks or delays. Under these circumstances it has been possible to keep the working force together, and there have been very few changes among the subordinates.

In the present volume the chapter on the Geodetic Survey is by Professor Edward A. Bowser; that on the Physical Description of the State, by Mr. C. Clarkson Vermeule, and that on the Climate, by Professor John C. Smock. All of these gentlemen have been long connected with the work.

Besides several smaller maps in the text the volume is accompanied by two large maps, one a geographical map of the State, the other a relief map, showing the elevations of the land. Both are admirable specimens of work and fully maintain the very high standard of the sectional maps heretofore issued by the Survey.

A Manual of Land Surveying, Comprising an Elementary Course of Practice with Instruments, and a Treatise upon the Survey of Public and Private Lands, Prepared for the Use of Schools and Surveyors: by C. F. R. Bellows, C.E., and F. Hodgman, C.E. Kalamazoo, Mich.; the Kalamazoo Publishing Company. (Price, $2.50.)

This is a revised and enlarged edition of a manual originally prepared in 1886, under the direction of the Michigan Engineering Society, the original object of which was to furnish a treatise which would deal with the practical questions continually meeting the surveyor in his work in the field, and which are not sufficiently treated by the books in existence, which deal entirely with the mathematical and instrumental part of surveying. With this view, in addition to the ordinary matter and tables given in such works, the present volume contains nearly 200 pages on Original Surveys, on Section Lines and Subdivisions as used in the surveys of Government lands, on Resurveys, Relocation of Landmarks and smilar questions, and on legal questions connected with the practical work of a land surveyor. This cannot fail to be of very great use both to those engaged in practical work and to students, and it certainly supplies a great deal of information which has not heretofore been readily accessible. It is the most practical work on the subject which has come under our notice, and a "preliminary survey" of its pages has failed to show any material errors. The book, we are informed, is already in use in a large number of colleges and technical schools.

It is published in a very neat form, and is bound as a pocket-book, its size and arrangement making it convenient for use as a field companion for the engineer as well as in the office.

Car Truck and Track Equipment. Issued by the Ramapo Wheel & Foundry Company, Ramapo, N. Y., and the Ramapo Iron Works, Hillburn, N. Y.

This is an illustrated catalogue which describes the different articles manufactured by the two companies whose names are on the title-page. These are, first, car wheels, in the manufacture of which the Ramapo Wheel & Foundry Company has long been celebrated. The wheels made by this Company are of two kinds—first, the cast-iron chilled wheels, and, second, steel-tired wheels. The quality of cast-iron wheels, like that of many other things—a pudding or a cocktail, for example—depends upon the quality of the material put into them. The irons used by the Ramapo Company are from the celebrated Richmond and Salisbury mines, which have been worked for a hundred and thirty years, and are especially suited for the manufacture of wheels.

The demand for steel-tired wheels has led Mr. Snow, the President of this Company, to design two different patterns of wheels of this kind. One of these has a cast-iron hub and cast-iron center which is held between two wrought-iron plates, all securely bolted together. One of the plates acts as a retaining ring to hold the tire. The other form of wheel has a solid cast-iron center. The tire is held on by a flange on the outside rolled on the tire, and which locks into a groove turned in the face of the wheel center. On the back the tire has a groove turned into it with a cut ring sprung in, which holds the tire in its place. A variety of cast-iron wheels for street, plantation, and other cars are illustrated.

This Company also makes a specialty of the manufacture of brake-shoes, among them the Congdon shoe, which is a combination of cast and wrought iron. It is, perhaps, not as generally known as it should be that this Company has been authorized by the Master Car-Builders' Association to manufacture and supply standard patterns of the Christie brake-shoe, which that Association has adopted as a standard.

The Ramapo Iron Works is an establishment organized by some of the same parties who are interested in the manufacture of wheels, and is located within about a mile of the older establishment, and makes switches, switch-stands, frogs, crossings, signals, castings, and general track equipment. Its products are very fully illustrated and described in the catalogue before us, the engraving of which is excellent, the typography good, and the paper luxurious, and which is a model of what such a catalogue should be.

Second Annual Report of the Interstate Commerce Commission: Thomas M. Cooley, William R. Morrison, Augustus Schoonmaker, Aldace F. Walker, Walter L. Bragg, Commissioners; Edward A. Moseley, Secretary. Washington; Government Printing Office.

The Report of the Interstate Commerce Commission for 1888, which details the work of the second year of the Commission, is an able and interesting document, which should be widely read and carefully considered.

Dealing as it does, necessarily, with the financial rather than the technical side of railroad affairs, a careful or even general analysis of the report would be outside of the subjects usually considered in these pages, though the points considered by the Commissioners have so wide a range, and are presented in such a manner that they command the attention of all who are interested in any way in railroads, and this practically includes the whole community.

There are few who realize the task which was given to the Commission, in the attempt to unify and bring under a general system the vast interests of our interstate commerce, which has grown up so rapidly, without control and under various State regulations, or practically without regulation beyond the very elastic one of the patience of stock and security holders, or of the public.

The task of teaching those unaccustomed to more than this nominal control was alone one of the greatest difficulty, and on the other side the Commission had to face the indifference and ignorance of the public, who looked only to local and individual interests.

Their work has, therefore, been chiefly educational on both sides, and though this report shows that it has been done with both ability and tact, it also shows that there is a large work yet before the Commission, and impresses the importance of that work upon the reader.

The discussion of unreasonably low rates, and their effect, not only upon the corporations, but upon the public mind, is one of the most useful chapters in the report, showing, as it does, the fallacies affecting popular opinion on that point; and while it deals unsparingly with the errors of railroad management in that particular, does not fail to point, out that the public is equally to blame, and by its readiness to grasp at a momentary advantage is willing to inflict a real injury upon its own interests.

The further fallacy of the unity of all railroad interests is clearly and ably dealt with, and the points of the effect of the law upon cities, and the difficulties which surround the question of a uniform classification, are stated with equal care and in a manner which cannot fail to remove many of the erroneous impressions which exist in regard to both those, to all but careful students, rather obscure points, and thanks are due to the Commission for presenting them in a manner which renders them so clear to the general reader.

If it were within the limits of this notice, it might be possible to take exception to the forms of annual reports issued by the Commission, though the points open to criticism are those of detail rather than of general scope; and it would be impossible to deal with these without a longer and more careful inquiry than is possible here.

In conclusion, it can only be said that the Commission has shown by this report that it has amply proved the necessity of its existence and the wide field of usefulness which is open to it in the future.

ABOUT BOOKS AND PERIODICALS.

The Technology Quarterly, issued by the students of the Massachusetts Institute of Technology, has in the December number an exhaustive article on Tests of the Strength of Cast Iron, by Professor Gaetano Lanza. There are also several other interesting articles by students and graduates of the Institute.

A new monthly, called Electric Power, has made its appearance, its object being to set forth the advantages of the electric motor as a machine for the distribution of power. It certainly has a field to fill which is already large and is rapidly widening. It is published at 150 Broadway, New York, and is edited by Ralph W. Pope and George H. Stockbridge, both gentlemen well known as electrical engineers.

The Century Magazine for February gives a map of Siberia, showing the route followed by Mr. Kennan in his travels in that country. It appears that the greater part of his journey was on substantially the line which will be followed by the Siberian Pacific Railroad when it is built.

Mr. Edward Atkinson is the author of an interesting article in the same number on Slow Burning Construction, written with special reference to public buildings.

In Harper's Magazine for January, Charles Dudley Warner tells of the coal, iron, and limestone deposits of Eastern Kentucky, and of the recent remarkable railroad development of that State, which has taken a new start after standing still for 20 years, in spite of its great natural resources. The article is interesting, though some of its statements seem rather enthusiastic.

An illustrated article on the Evolution of the Ferry-Boat, by S. Bayard Dod, appears in Harper's Weekly for January 5. This article contains an account of the progress made in ferry-boats since 1659, with special reference to the ferry from New York to Hoboken. During that year reference is made to an existing ferry which was kept by Cornelius Dircksen, who, having a farm near by, came at the sound of a horn, which was hung on a tree, and ferried passengers over for three stivers wampum. A description is also given of the horse-boat, which was the next form of ferry-boat, the power secured being equal to 40 oars or 10 times greater than the row-boats; the *Fairy Queen*, the old *Pioneer*, and other boats propelled by steam are illustrated, and the writer ends with a description of the handsome, modern ferry-boat *Bergen*, now being built for the Hoboken Ferry Company, which is the latest development of its class.

An account of the *Puritan*, now awaiting completion at the Navy Yard, Norfolk, the highest type of coast-defence vessel yet laid down in this country, is given in the same number.

BOOKS RECEIVED.

Annual Report of the Chief of the Bureau of Steam Engineering, Navy Department, for the Year 1888: Engineer-in-Chief George W. Melville, Chief of Bureau. Washington; Government Printing Office.

Selected Papers of the Rensselaer Society of Engineers: Edited by the Committee on Publication. Troy, N. Y.; published for the Society. This number includes a reprint of Mr. William H. Burr's paper on the Theory of the Masonry Arch, originally published in 1881, and now reproduced, with a few changes and additions, to meet the continued demand for it, the first edition having been exhausted.

The Technic: Annual of the Engineering Society of the University of Michigan. Ann Arbor, Mich.; published by the Society. This volume contains selected papers read before the Society during the year, some account of its proceedings, items of interest relating to the University and other well-chosen matter. It is illustrated by portraits of Professor Greene and the late Professor Cheever.

Transactions of the Institution of Civil Engineers of Ireland: Fifty-second Year, to June, 1887. Dublin, Ireland; published for the Institution.

The Economical Production of Charcoal for Blast-Furnace Purposes: by Olin H. Landreth, Engineering Department, Vanderbilt University. Nashville, Tenn.; reprinted from the *Proceedings* of the American Association for the Advancement of Science.

Gear Tables for Laying out Accurate Tooth Profiles for the Use of Patternmakers, Machinists, Draftsmen, and Students: by J. F. Klein, Professor of Mechanical Engineering, Lehigh University. Bethlehem, Pa.; Edwin G. Klose, Manager.

Memorial to the State Legislature of Missouri: Draft of an Act to Promote the Safety of Bridges. Issued by the Engineers' Club of Kansas City.

UNIVERSITY OF MICHIGAN; THE PRESIDENT'S REPORT TO THE BOARD OF REGENTS FOR THE YEAR ENDING SEPTEMBER 30, 1888. Ann Arbor, Mich.; published by the University.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY: TWENTY-FOURTH ANNUAL CATALOGUE, 1888-89. Boston, Mass.; published by the Institute.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, No. III. Ithaca, N. Y.; published by the University.

IMPERIAL UNIVERSITY OF JAPAN (TEIKOKU DAIGAKU): CALENDAR FOR THE YEAR 1888-89 (XXI-XXII YEAR OF MEIJI). Tokyo, Japan; published by the University.

IMPROVEMENTS IN THE CONSTRUCTION OF STEAMSHIPS AND RUDDERS AND IN LOCATING RUDDER AND PROPELLERS: BY WALFRID THEODOR SYLVEN. Washington; published by the Author.

THE VIVARTTAS SYSTEM OF CREMATING GARBAGE AND REFUSE. Plainfield, N. J.; issued by the Seaboard Sanitary Garbage Cremating & Refuse Utilizing Company, Seymour G. Smith, Secretary.

THE LONG-SUFFERING SHAREHOLDER. RAILROAD DIRECTORIAL MISMANAGEMENT AND GOVERNMENTAL OPPRESSION: BY HENRY WOOD. Boston; published by W. B. Clarke & Company.

THE TAYLOR IRON WORKS DIARY FOR 1889. Issued by the Taylor Iron Works, High Bridge, N. J. This Company has sent out its usual yearly reminder to its friends in the form of a very neat and convenient pocket diary, containing, besides the usual diary and memorandum pages, a variety of notes on strength and weight of metals, tables, and other information often very convenient for reference.

CALENDAR MEMORANDUM TABLET. Issued by Pedrick & Ayer, Philadelphia. This is a very convenient memorandum tablet for the desk, containing on each page spaces for memoranda for six days, and an engraving of one of the special tools made by the firm.

FINAL ESTIMATES AND CLASSIFICATION OF WORK.

To the Editor of the Railroad and Engineering Journal:

IN reading the paper on the Principles of Railroad Location in the January number of your JOURNAL, that chapter which relates to Final Estimates attracted my attention, and I wish to offer a couple of suggestions on the subject of Classification, based on a considerable and varied experience as engineer and contractor on railroad and other works.

An objection to the classification in the clause denominating boulders and detached masses of rock up to four yards in quantity as "loose rock."

I should rather make one-fourth of a yard the limit. A boulder of four yards will weigh say 18,000 lbs. It is necessary, ordinarily, to drill and blast boulders of one yard weighing 4,500 lbs., as in earth cuts. Where such boulders are usually found, contractors do not have derricks or other appliances for handling such stones, and where there are derricks it is not customary to rig them for a load of over one yard, while the ordinary small dump-car will not carry over two yards. Where classification is used it should be based entirely on the cost of excavating the materials, and it certainly costs more per yard to handle detached boulders or masses of two, three, or four yards than the same number of yards of solid rock in a rock cut.

I was engaged on the construction of a railroad where the specification stipulated that rocks up to 20 cubic yards in size were to be "loose rock," but that all rock that could not be removed without blasting was "solid rock." Of course the latter clause wiped out the former, as no one could handle a 20-yard mass of rock economically without blasting.

In the opinion of a number of eminent engineers with whom I have talked on the question of classification, as well as my own, work should be let without classification.

Contractors are usually far better qualified to estimate the cost of grading than engineers, and after examining the work carefully by means of test pits or borings, where the heavier cuts occur, can bid intelligently, taking the whole as one class; of course the price per yard would vary upon different sections as the materials to be excavated varied.

In eliminating classification, the most disputed and serious question between contractors and railroad companies is removed, and many vexatious delays in settlements and lawsuits averted.

The Pennsylvania Railroad—the most progressive, best maintained, and systematized, as well as the strongest railroad company in this country—is now letting its work largely without classification, which practice goes far to prove the theory to be a correct one.

Tarrytown, N. Y. FRANK NEARING.

PETROLEUM FUEL.

To the Editor of the Railroad and Engineering Journal:

AMONG much that is interesting in the RAILROAD AND ENGINEERING JOURNAL for November, 1888, is an article on page 509 on Petroleum Fuel. The comparative points made relative to the evaporating power of petroleum and coal are entitled to the most careful consideration and due respect, and the public is more widely affected by the facts contained in the statement made, than the casual reader or observer may comprehend. In a word, it touches the cash account of all who provide fuel for heating space or substance for comfort, power manufacturing, and domestic purposes. All of these reach out a long and powerful arm as positive as a grip of the devil-fish, and materially affect the bank account of all concerned, whether consumers or producers. But concomitant with the use of petroleum in a liquid state is the possibility, or reasonable fear of a destruction of life and property. It may be made as faithful a servant in trained hands as lightning, steam, or nitroglycerine, all of which are safe under the right conditions, but the public are not all mechanics, engineers, chemists and philosophers. Nevertheless, all are in some way interested in results from heat in this world—to say nothing of the next. Life is dear to all, and the majority prefer to stay in this world as long as they can, whatever their future crop may be from seed sown here. It is not good judgment for an engineer to calculate the tensile strength of iron, of any make and size, to make a chain to lift a load and have it just strong enough to lift it over the heads of living persons; he should steer clear of all possibility of accident when it can be done, and build a chain so that there can be no possibility of its breaking with a good load. So with liquid petroleum as fuel. Scientifically its combustion with water or hydrogen gas and air, etc., is all well enough, but is it not better to have it so that it is as safe as a loaf of bread—still preserving all the benefits of heat—than to have a liquid lightning to strike and consume? I do not mean by this the use of any system of absorption giving rise to danger and filth. Petroleum, or any grease or oil can be so heated as to be as safe and as neat as wood or coal, and still be equally effectual as in a more dangerous way.

I do not presume to argue points but to state facts. In the latter way—refined—it can be burned in any place where wood or coal is burned. Petroleum or any grease can be as effectually, safely, and neatly used as coal or wood, and can be kept in a box or coal-hod like them. I am not manufacturing this article for sale, but it is perfectly practicable, and were I not so much engaged I would, I think, bring this matter out for the public. I never have advocated it because "a little learning is dangerous"—and less is more dangerous. This maxim proves true all along the line of artisans, manufacturers, etc., of whom it can be truthfully said and corroborated that far too many think of their positions, or job that of facts, progress, improvement, quality, and cost of production.

GEORGE VINING, M.D., Chemist.

THE DEVELOPMENT OF THE MILITARY RIFLE.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page* 8.)

MAGAZINE OR REPEATING RIFLES.

The above was the condition of the military small-arm armament at the beginning of 1884. Magazine arms of the Spencer, Henry, Burnside and Sharp patterns had been used to a considerable extent during our Civil War by scattered organizations, but the system, both here and abroad, was confined almost wholly to arms for mounted troops--no nation having adopted it for infantry.

During the three years following the date mentioned the Germans converted their Mauser (1884) into a magazine gun, with a tubular magazine under the barrel for eight cartridges. Austria adopted the Mannlicher repeater (1885), an entirely new arm; the magazine, in the shape of a tin case or box holding five cartridges, was attached under the breech and fed directly into the receiver, and was removed and thrown away when empty. The English military authorities decided to convert their Martini-Henry into a magazine gun of reduced caliber, but before the change had been completed the proposed adoption of a still smaller caliber by Continental powers stopped further progress.

The latest revolution in small-arms is as complete, and the changes suggested quite as radical, as any that have preceded it. Professor Hebler, a German scientist, seems to have been one of the first to advocate a decided reduction in the caliber of military rifles (1886). The announcement that with a bullet of only about 8 mm. diameter, greater range, accuracy and penetration, with less recoil, could be obtained than with those of any of the existing systems, was received with incredulity, if not ridicule, by the military experts. Investigation and experiment have shown, however, that these claims are fully substantiated, and almost before the re-armament of the great Continental armies with the large-bore magazine rifle has been completed, the work and vast outlay of another re-armament must be undertaken. The advantages of a lighter arm with a lighter bullet, provided they will do the work required of them, are obvious, and, with quick-firing arms, in no way more than in the largely increased number of cartridges that can be carried by the individual soldier.

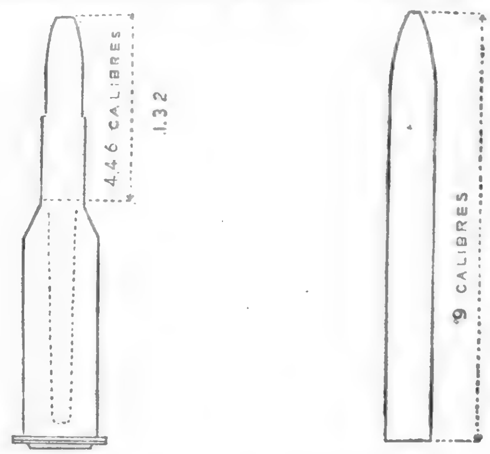
In the Hebler system the rifle has a caliber of 7.53 millimeters (0.296 in.). The cartridge case, of thin steel, contains a 225-grain bullet, 4.46 calibers in length, and a charge of 83 grains of compressed powder, perforated throughout its length to secure instantaneous ignition of the whole interior surface of the charge. The bullet is covered with a thin nickel-plated steel shell (fig. 16).

The French, in their Lebel rifle—which is said to be a modified Gras—have an arm for which greater results are claimed than those obtained from the Hebler. The details concerning this arm and its ammunition are guarded so closely that but little reliable information has been obtained concerning it. It has a caliber of 8 mm. (0.315 in.); uses a smokeless powder, from which an initial velocity of 630 meters and a range of 4,200 meters is claimed, against an initial velocity of 600 meters claimed for the Hebler. The bullet is said to have the extraordinary length of *nine* calibers. If these reports are correct, fig. 17 would represent the actual dimensions of this bullet. The powder is supposed to be a gun-cotton or nitrated powder of some kind. Like the Hebler bullet, that of the Lebel is steel cased. The object of this metal covering for the bullet is that in all these small-caliber arms the relative length of the projectile to its diameter is so great that an excessive twist of groove is necessary to obtain sufficient rotary motion to prevent its "tumbling." Lead of itself was found too soft—it stripping badly—and after many experiments with various alloys of lead, and with all-steel projectiles, the best results were obtained by casing a lead bullet with copper, soft steel, nickel or German silver. The magazine of the Lebel rifle is tubular and under the barrel, and contains eight cartridges. More than 300,000 of these arms have already been issued to the French army, and it is expected that before the close of the present year the entire active force will be re-armed with the small caliber magazine rifle.

The new small-caliber Austrian magazine rifle, the manufacture of which that Government is pushing with all possible despatch, is of the Mannlicher model, of 8 mm. caliber, using a 240-grain steel-cased bullet, four calibers in length, and a charge of 62 grains of compressed brown powder. An initial velocity of 520 meters, with a range of 3,800 meters, is claimed for this arm. The issue of the new arm has already begun.

In Germany it is said that a small-caliber magazine rifle has been decided upon, but no details of the proposed arm have as yet been published; but it is presumed that it will be a modification of the Mauser, their present arm.

The English military authorities, after many experiments with several patterns of magazine rifles, seem to have settled finally upon the Lee—or, as they call it, the



16 17

Improved Lee. This is an American arm, and one of the three issued to our own troops for trial four years ago. The caliber has been reduced to 0.303 in., the magazine is detachable, contains eight cartridges, and is attached just in front of the trigger-guard. The cartridge has not yet been decided upon. The one proposed uses 70 grains of compressed black powder and a copper-covered bullet of 217 grains.

In the United States the question of a magazine rifle of any kind is still in abeyance. In 1885 a considerable number of arms of the Lee, the Chaffee-Reece and of the Hotchkiss were issued to the army for trial. After a trial of something over a year, reports were submitted to the Ordnance Department by the officers having them in charge. In a majority of these reports preference was given to the Lee, but its adoption was not generally recommended. Many of the objections to this arm seem to have been of a trivial nature—that it was not adapted to the manual; could not use reloaded ammunition satisfactorily; that the sights were objectionable; and, the most serious one of all, that it was liable to discharge during the process of loading. At any rate, in this case our English cousins seem to have been able to turn the tables upon us and improve upon a Yankee invention. In the mean time, we are, Micawber-like, "waiting for something to turn up" in the line of a magazine rifle that shall please our Ordnance Department, conscious that we possess an arm which, fifteen years ago, might have been near the head of the list, but is certainly now rapidly approaching the foot.

In the recoil system we have the latest phase in the development of the military rifle. In it the force of recoil is made to do a part or the whole of the work of reloading the piece. Three different methods of utilizing the force of recoil have been developed. In the Freddi rifle (Italian), when the piece is fired the recoil forces the barrel (which is free to move in the direction of its axis) and breech-block to the rear and compresses a spiral spring. When the recoil is expended this spring throws the barrel

forward, but the breech-block is caught and held to the rear, leaving the receiver open. A fresh cartridge is inserted by hand. By pressing a button the breech-block is released and flies forward, closing the breech. The piece is cocked when the bolt first moves to the rear under the impulse of the recoil. In this system the force of recoil is made to perform the operations of opening and closing the breech mechanism, in addition to ejecting the empty case —operations which, in the ordinary magazine rifle, have to be performed by hand. A leather case, holding twelve cartridges, may be attached to the side of the piece, and great rapidity of fire secured.

In the Paulson system the breech mechanism is opened and the shell extracted by means of a rod attached to the breech-block; the powder gases being allowed to enter an aperature in the barrel and act upon the head of the rod as upon a piston. The cartridge is inserted by hand, and the release of a spiral spring, which has been compressed by the recoil, closes the breech. This arm may be used as a repeater by attaching a magazine to the side of the piece.

The Maxim recoil rifle is constructed upon the same principle as the machine gun of the same name, and in its action is wholly automatic. The recoil, acting directly upon the breech-block, forces it to the rear and compresses a spiral spring—the empty cartridge case being extracted at the same time. The cartridges, seven in number, are inserted by hand in as many receptacles in a revolving drum under the receiver. When the breech-block moves to the rear under the impulse of recoil, a system of levers acting on the drum revolves it under the receiver to supply a new cartridge. The compressed spring then forces the breech-block forward, pushes the cartridge into the chamber, and closes the breech. If the trigger is held back the firing-pin will be released and the firing continued until the cartridges are exhausted. The breech-block can be operated by hand and the piece used as a single loader.

The most important advantage of the introduction of the small-caliber rifle, from a purely practical military point of view, is, as has been said, the largely increased number of cartridges the individual soldier can carry upon his person to the field of battle, which has become a question of vital importance with the introduction of quick-firing arms. As showing how greatly this diminution of caliber has effected this supply, it may be said that with the Lebel rifle 116 cartridges of the old caliber are equivalent in weight to 220 of the new; that the cartridge proposed for the Lee has but little more than half the weight of that of the Martini-Henry; that with the Austrian 8 mm. rifle, 100 of the old caliber equals 146 of this arm; and that a soldier armed with the Hebler rifle could carry 107 rounds of ammunition as an equivalent of 80 rounds of our own Springfield.

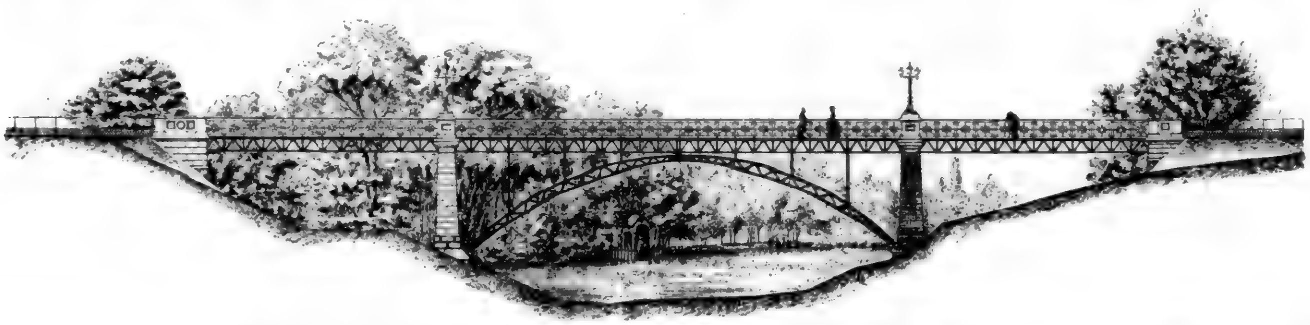
A GERMAN FOOT-BRIDGE.

THE accompanying engraving, from *Le Genie Civil*, shows a foot-bridge of very neat design, which crosses the River Oker in the park which has been made on the site of the ancient fortifications which formerly surrounded the city of Brunswick in Germany. This bridge was built after the plans of M. E. Haeseler, Professor in the Polytechnic School at Brunswick.

Near the bridge the river makes a curve of about 40 meters' radius, and the banks are high. To join the park road on the left bank with the city street, which runs near the right bank of the river, a slight grade was necessary, and the bridge has a fall of 1.50 meters in its entire length. At the point where it is built the soil is chiefly sand, and it was necessary to rest the piers on piles. Upon these piles there is built a foundation of masonry of cut stone, upon which the piers rest. The masonry of the piers and abutments is of limestone.

At the point of crossing, the river is about 22 meters in width, but the central span is 24 meters in length, the general form and design being shown in the engraving. The side spans nearest the banks, which are plain girders without the supporting arch of the central span, are 13 meters in length. These side spans were used instead of filling in, in order not to interfere with the view of the park. The bridge is 4 meters in width, the whole being given up to the foot-walk with a railing on each side.

The side-spans have four simple lattice girders 13.40 meters in length, and spaced 1.20 meters apart. These girders carry the cross-beams supporting the foot-walk. The central span consists of two arched girders 3 58 meters apart, the ends resting in sockets made in the piers, and carrying the girders supporting the roadway, as shown in the cut.



In order to resist wind pressure the girders of the side spans are tied together by cross-bracing and by diagonal rods. In the central span the arched girders are also joined by cross-bracing, while the lattice girders above the arch are braced in a similar way. The ends of the arched girders are joined to the sockets on the piers by pins 60 mm. in diameter.

The planking of the foot-walk is 85 mm. thick, and is of oak and of beech. The beech planking was treated with chloride of zinc before being laid down, and has worn exceedingly well during the time it has been in service. The planking is fastened to the transverse girders by bolts. The guard-rail is 10.8 meters in height above the planking.

The total cost of this bridge was $9,200, the masonry work and substructure costing $5,200 and the iron-work $4,000. The design is certainly very neat, and agrees very well, apparently, with the nature of the surroundings.

NOTES ON STEAM HAMMERS.

BY C. CHOMIENNE, ENGINEER.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 30.)

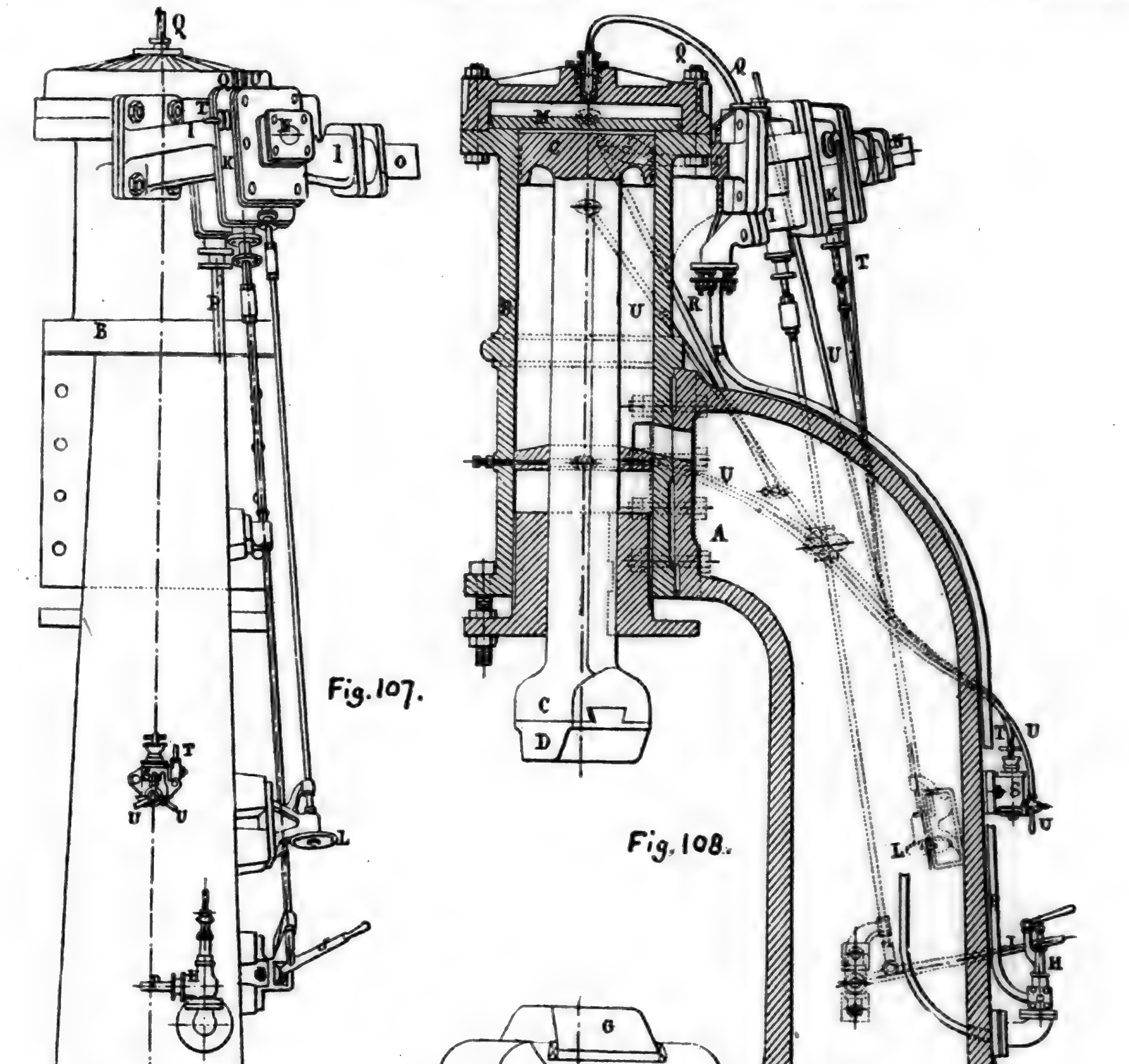
CHAPTER XXXI.

THE FARCOT DOUBLE-ACTING HAMMER.

THE principle upon which this hammer is constructed differs from that of other similar tools in this respect, that the lifting of the hammer is produced by a steam-chest or reservoir placed for that purpose below the cylinder. This type is represented in figs. 107 and 108, which show a hammer of 1,250 kilos., which is so planned as to leave the anvil entirely free. The cylinder incloses an iron piston, the rod of which has a rectangular section, thus preventing any rotary movement. At the lower end of this rod is carried a steel block, which forms the ham-

mer proper and which strikes on an anvil fixed to the bed-plate.

The cylinder *B* has its upper head of cast iron made with a recess greater in diameter than that of the piston; within this recess is placed a light plate which works freely like a piston. Steam is admitted to this head above the plate, as shown at *M*, and thus serves as an elastic cushion ishes in this reservoir. The capacity of the latter can be increased by the addition of water. The steam which it contains produces a counter-pressure and causes the piston to ascend as soon as the exhaust-port above it is opened and the upper end of the cylinder placed in communication with the air. This steam is not exhausted, but acts as a simple spring to lift the hammer after the down stroke.



THE FARCOT DOUBLE-ACTING HAMMER.

to prevent any shock to the upper part of the cylinder, in case the stroke of the piston is prolonged too much.

In this system the frame is made hollow, and it forms a reservoir in which steam is kept at a constant pressure—about two atmospheres—by means of a balanced valve, which admits fresh steam whenever the pressure dimin-

The result of this arrangement is that the waste space in the steam-chest and ports, which in other hammers occasions loss of steam, is dispensed with.

The force of the blow is regulated by the pressure and by the duration of the admission of steam above the piston; this steam forces down the hammer, at the same time

compressing the steam in the reservoir *A*, which ought to be kept at a pressure at least three atmospheres below that of the boiler. As soon as the valve is left free it is raised by springs placed on the rod *L*, and, the steam above the piston escaping, the hammer is lifted by the pressure of the steam in the reservoir below the piston, which expands to put itself into equilibrium with the weight of the hammer. The number of blows struck by the hammer then depends on the rapidity with which the hammerman can move the hand-lever *J*, and in the same way the stroke is determined by the action of this lever, since the hammer ceases to rise as soon as steam is admitted above the piston *C*.

The force of the blow can be decreased by stopping the admission of steam before the end of the stroke of the piston, so that the expansive force of the steam can be utilized, and the hammer can thus be worked very economically.

The following examples will show the value of this system of hammer, in comparison with a single-acting hammer. If we suppose a single-acting hammer of 1,250 kilos. and 0.900 meter stroke, the work produced during this fall will be :

1,250 kg. × 0.900 m. = 1,125 kilogrammeters.

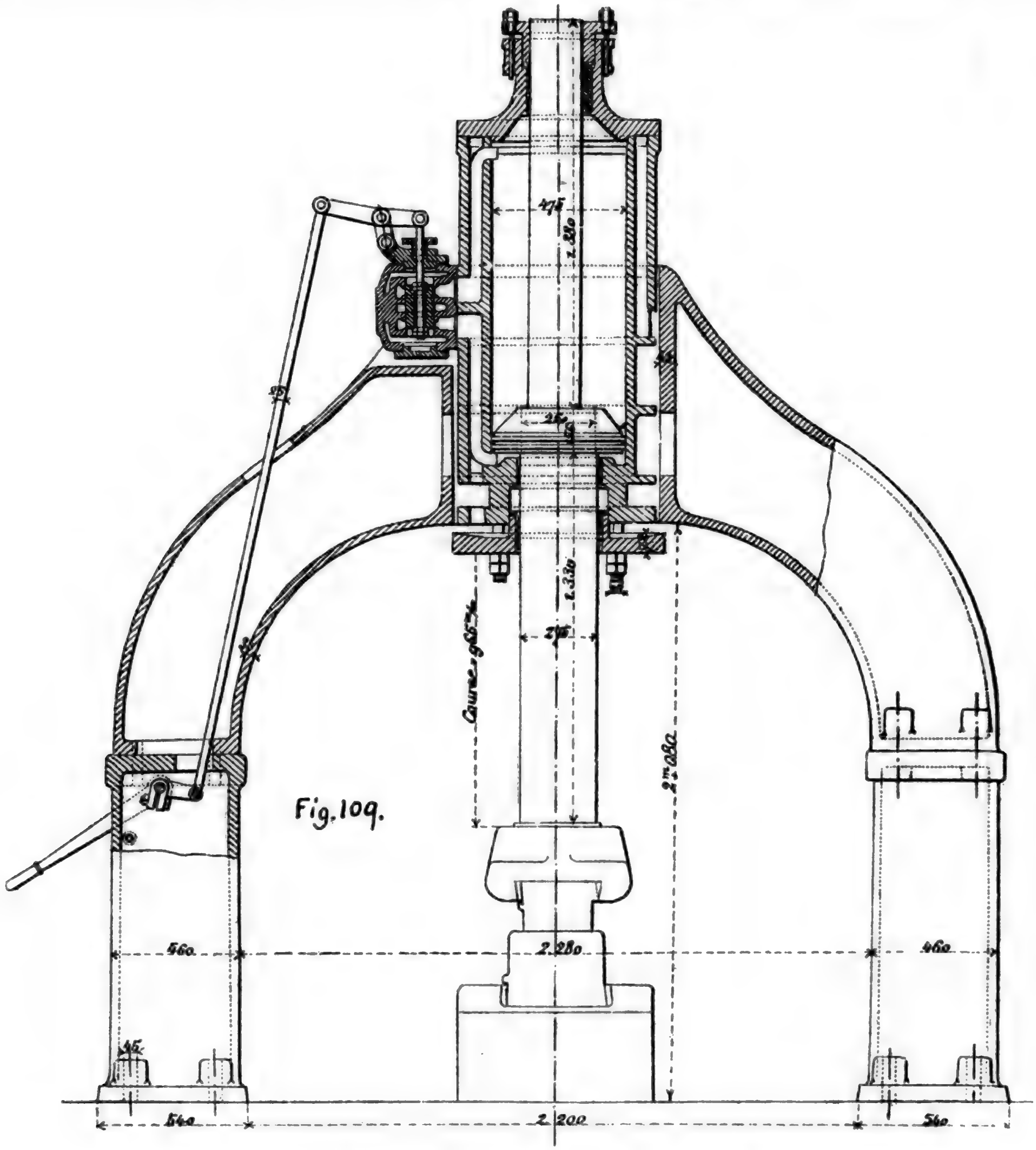
With a Farcot hammer of the same weight, having a cylinder 0.512 meter diameter working with a steam pressure of 6 kilos. and a counter-pressure of 2 kilos., the pressure of the piston will be : 0.2058 sq. m. × (6—2) = 8,232 kgm. This pressure of the piston being added to the action of gravity will give for the downward stroke a working equivalent of (8,232 + 1,250) 0.900 = 8,533 kilogrammeters. The ratio between these two will then be 1,125 : 8,533—that is, 1 : 7.58.

If now we assume that steam acts at full pressure only during one-third of the stroke, and that it expands during the other two-thirds, the mean pressure of steam would become 4.18, and the total pressure exercised on the piston would be :

0.2058 sq. m. × (4.18—2) = 4,486 kilogrammeters.

The work done during this descending stroke will be :

(4,486 kg. + 1,250 kg.) × 0.900 = 4,662 kilogrammeters.



THE SELLERS DOUBLE-ACTING HAMMER.

The ratio between these two will then be only 1,125 : 4,662—that is, 1 : 4.14.

In the accompanying illustrations *A* is the frame ; *B* the steam cylinder ; *C* the piston ; *D* the shoe ; *E* the foundation-block ; *F* the anvil ; *G* the die ; *H* the balanced valve, the object of which is to keep at a constant pressure the steam contained in the hollow frame, this pressure being sufficient to raise the piston after the stroke ; *I* is the steam-chest ; *J* the hand-lever by which the hammerman works the valve ; *K* the steam-valve, operated by the hand-wheel *L* ; *M* is the recessed head to which is admitted steam, forming a cushion to take up the shock in case the upward stroke is prolonged too much ; *N* is the steam-pipe connecting to the boiler ; *O* is the exhaust-pipe leading from the steam-chest ; *P* is the pipe conveying steam from the steam-chest to the balanced valve *H* ; *Q* is a small pipe through which steam is admitted to the recessed head of the cylinder ; *R* is the small pipe through which steam can escape from the recessed head ; *S* is a lubricator, and *T* is a pipe conveying steam to *S*, while *U* is a pipe conveying oil to different parts of the hammer.

CHAPTER XXXII.

THE SELLERS DOUBLE-ACTING HAMMER.

Mr. William Sellers, of Philadelphia, has introduced in the United States the Morrison steam hammer, shown in fig. 109, and the attention of this engineer has been constantly given to improvements of this tool in such a way as to increase its efficiency and durability. The essential point of the Morrison system is that the striking part of the hammer is composed of a long rod of wrought iron,

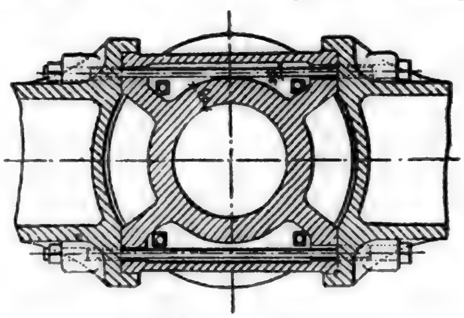


Fig. 110.

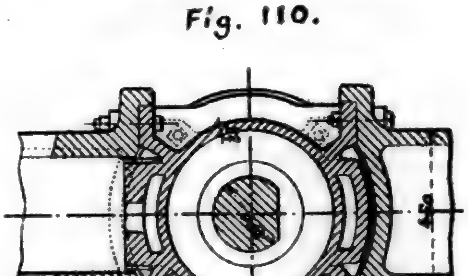


Fig. 111.

with a piston fastened on the upper end of the rod, passing through the cylinder-head and serving as a guide. This part of the rod has a flat place formed upon it to prevent any rotary movement. It is of less diameter than the lower part, as the greater weight of the metal should always be found nearest the point at which the blow is struck, and each of these parts is proportioned to the work which it has to do. This system leaves consequently the space below the cylinder completely free and gives the hammerman every facility for doing his work.

The frames are made with each leg in two pieces, and carry the cylinder on their upper part ; between the cylinder and the frame an elastic cushion is placed. Between the two parts of each leg of the frame also there is placed a thin plate of wood, which permits a certain movement under the strains resulting from the shocks of the hammer, the object being to decrease the chances of breakage.

For hammers having very hard work the rod is made of steel and the piston is reinforced.

The lower bolts which fix the cylinder to the frames are arranged in such a way as to be exposed to a current of air in order to decrease the expansion resulting from the radiation of heat from the piece to be forged.

There is nothing particular to note in the foundations. The ratio between the weight of the hammer and that of the anvil is 1 : 5 when the hammer is intended to work iron ; for steel its ratio is 1 : 8 at least, and is sometimes increased to 1 : 10. It must be understood that the nominal weight of this hammer includes only the weight of the rod, etc., and that no account is taken of the pressure exercised by the steam upon the piston. The force of the blow necessarily varies according to the size of the piece to be forged, the ductility of the metal, and the pressure of steam.

All these hammers are provided with an exhaust of the Collin system, the exhaust-pipe fixed to the steam-chest extending into a large pipe fixed to the roof, while the water of condensation escapes through a small pipe provided for that purpose.

These hammers below 1,000 kilos. have only a single frame, and work automatically ; those above that weight have a double frame, as shown in the cut, and the valves are worked by hand.

It will be seen that this arrangement can only be used for comparatively short strokes, and that for heavy work or die-work having a large surface this method of guiding the piston from above would be insufficient.

CHAPTER XXXIII.

BEMENT, MILES & COMPANY'S 2,700-KILO. HAMMER.

This hammer, which is shown in figs. 112, 113, and 114, is made by Bement, Miles & Company, Philadelphia, United States ; it is of the Morrison system—that is to say, with an independent bed-plate and a double frame, carrying the cylinder on its upper part.

The piston-rod is 0.250 meter diameter, and has on the side a flat place, preventing any rotary movement. The stuffing-box serving as a guide to the piston-rod is of bronze, and has a special arrangement by which any wear can be taken up.

This hammer is not automatic, but is worked by hand. The distribution of steam is made by a circular balanced valve, the upper part of which is exposed only to the pressure of the exhaust steam, thus dispensing with stuffing-boxes. The valve admitting steam to the steam-chest can be worked by a lever placed conveniently for the hammer-man.

Between the surfaces of contact of the cylinder and the frame there are placed copper plates of 1.5 mm. in thickness to obviate the effects of shocks. Under all the nuts and the smaller bolts are placed washers of vulcanized fiber, while the larger bolts have concave steel washers. In this way there is obtained a certain elasticity which prevents breakage of bolts.

The frames rest upon two blocks of cast iron, to which they are fixed by heavy bolts. These two plates are joined together by wrought-iron rods with T-heads, but to prevent these rods from working out of the grooves in which they are placed, there is upon each head an iron plate riveted to the block.

The foundations are sufficiently shown in the illustration to require no detailed description. In the hammer shown the cylinder is 0.610 meter diameter, the stroke is 1,220 meters, and the weight of the hammer is 2,700 kilos.

This hammer is specially intended for forging and drawing out bars. For die-work the system of guides is hardly well adapted.

CHAPTER XXXIV.

BEMENT, MILES & COMPANY'S 15,500-KILO. HAMMER.

This hammer, shown in figs. 115, 116, and 117, was built in 1880 by Bement, Miles & Company in Philadelphia, for the Steel Works of Park Brothers & Company in Pittsburgh.

The frame is composed of four hollow legs of rectangular form, built up of plates and angle-bars. Each group of two legs carries a girder which unites them by means of bolts, and these girders in their turn carry the upright frames to which are fixed the guides. These upright frames are joined at the top by the steam cylinder ; the girders

are joined together by heavy wrought-iron plates, somewhat like the Creusot hammer.

The diameter of the steam cylinder is 1.010 meters, and the maximum stroke of the hammer 2.750 meters. The piston-rod is of steel, and its diameter is 0.280 meter. The rod is attached to the piston by a nut.

This hammer, being intended to forge very heavy pieces, surfaces, and is so easily moved that the safety levers, placed above the sides and worked by a lug placed on the hammer in order to prevent accidents, should the latter be lifted too high, is really almost unnecessary.

The hammer is intended to forge steel. The guides are of wrought iron, and are bolted to heavy plates of iron fixed to the upright frames.

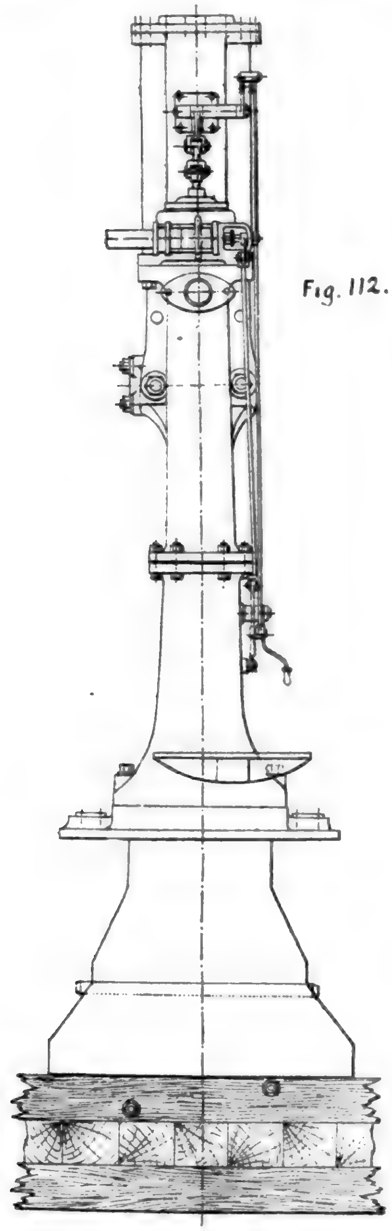


Fig. 112.

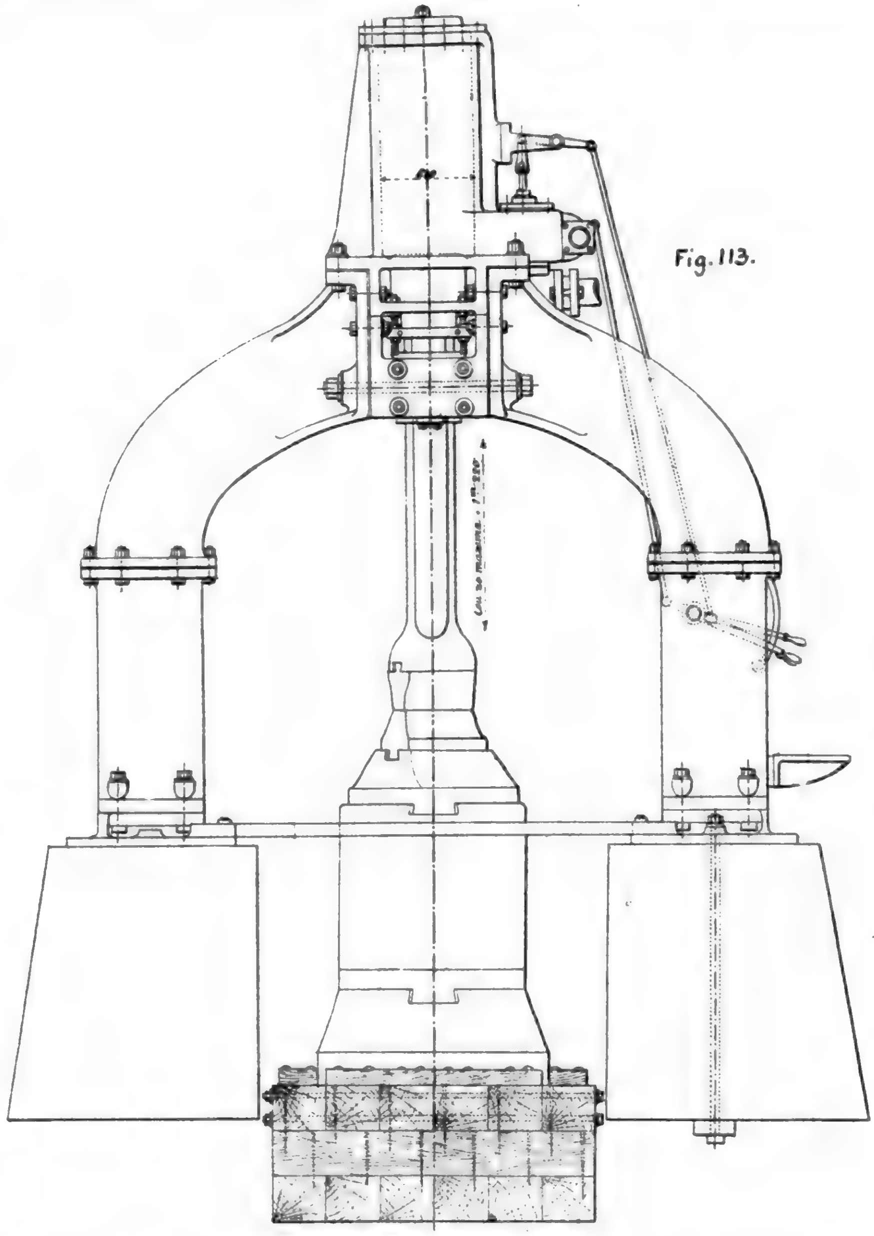
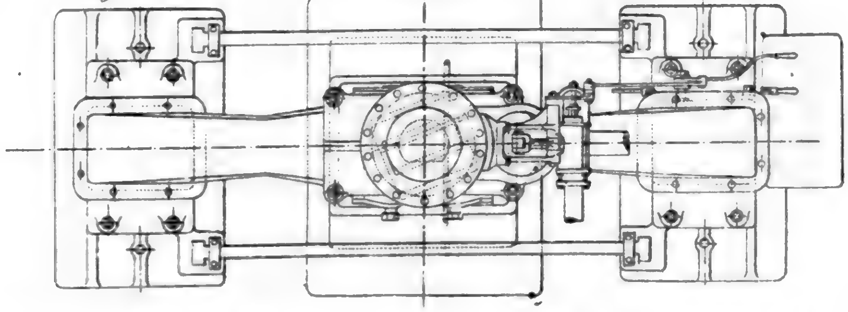


Fig. 113.

Fig. 114.



BEMENT, MILES & COMPANY'S 2,700-KILO. HAMMER.

is not automatic, but is worked by hand by the hammerman, who is placed on the level of the ground and between the two legs, and has near him a lever moving the valve admitting steam to the chest, as well as the lever commanding the distributing valve. This valve is flat and is perfectly balanced; it works vertically between two rigid

The plates of the frames are 28 mm. thick, those of the girders 21 mm., and those of the upper frame 15 mm. All the joints of the plates are planed, in order to obtain a perfect fit. The rivet-holes, the diameter of which is 30 mm., are countersunk and the rivet-head is joined to the body with a fillet of 5 mm. radius. The legs rise two by

two on a huge mass of cast iron, which in its turn is bolted down to a heavy masonry foundation. These two cast-iron blocks are joined together by two bolts 0.110 meter diameter placed on each side of the anvil block.

fiber 6 mm. thick. This fiber has the color and appearance of leather, and is said to last as well as oak wood. The anvil, the weight of which is 1,050 kilos., has the form of a truncated pyramid with a rectangular base,

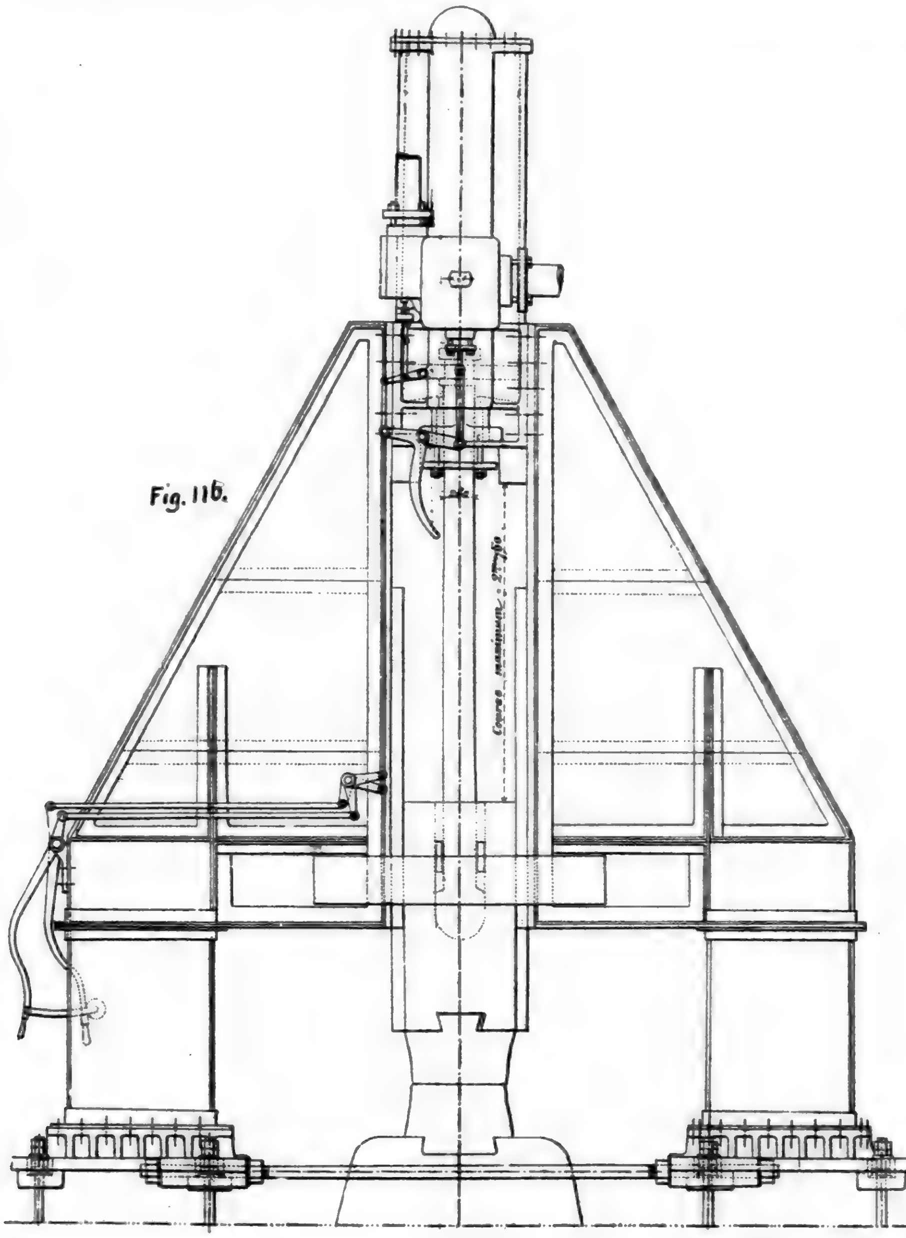


Fig. 116.

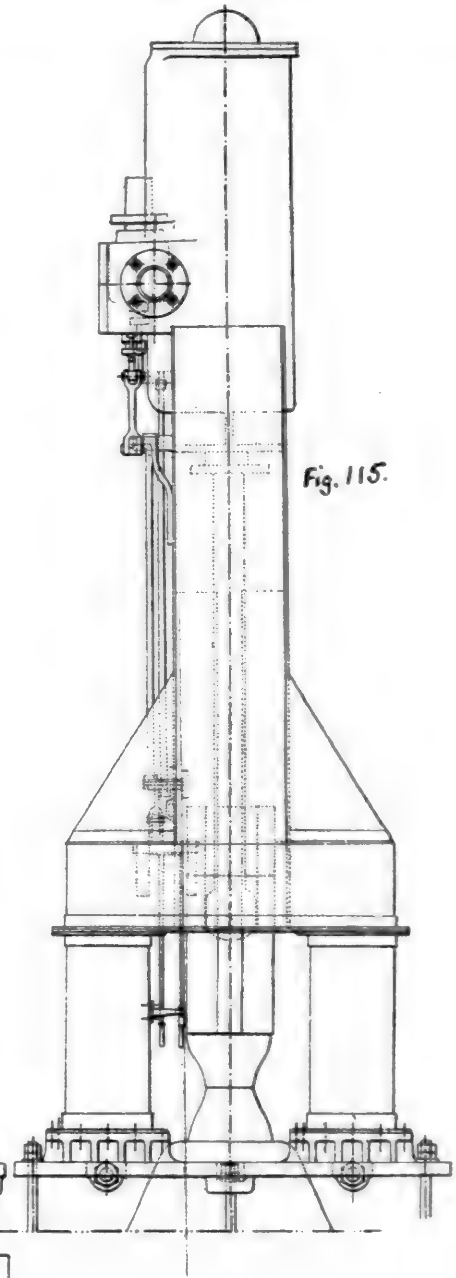


Fig. 115.

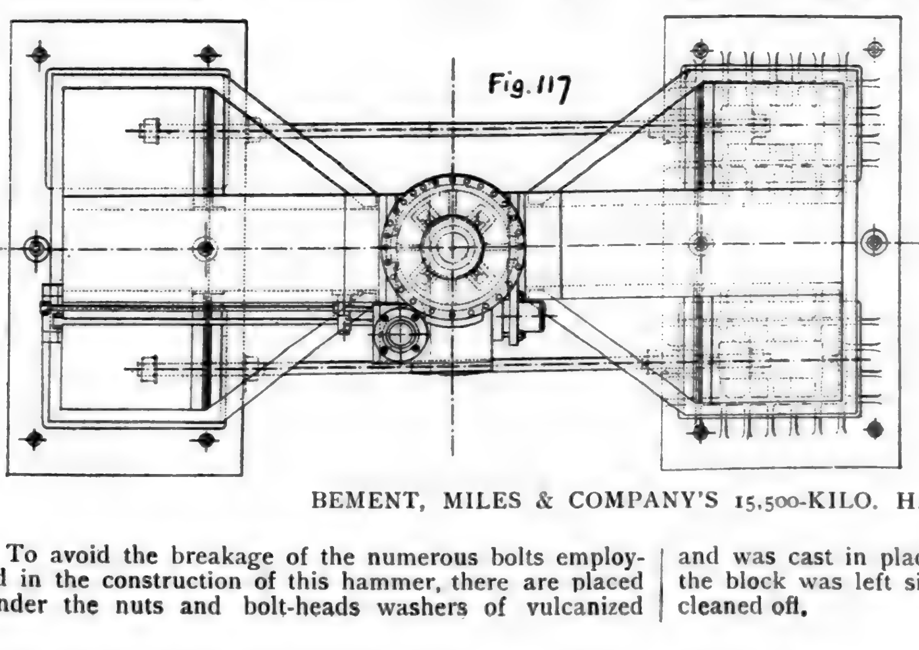


Fig. 117

BEMENT, MILES & COMPANY'S 15,500-KILO. HAMMER.

To avoid the breakage of the numerous bolts employed in the construction of this hammer, there are placed under the nuts and bolt-heads washers of vulcanized

and was cast in place. The casting took $4\frac{1}{2}$ hours, and the block was left six weeks in the sand before it was cleaned off.

The foundations were made with great care and in the following way:

1. A bed of concrete.
2. A layer of oak blocks 6.700 meters long and 0.360 meter square.
3. A second layer of oak blocks of the same size placed at right angles with the first, and strongly bolted to it.
4. A cast-iron plate 4.880 by 3.050 meters in size and 0.200 meter thick.
5. Another pile of oak timbers of the same section as those below, and altogether 3.350 meters in height.
6. On top of this huge mass of wood the anvil-block.

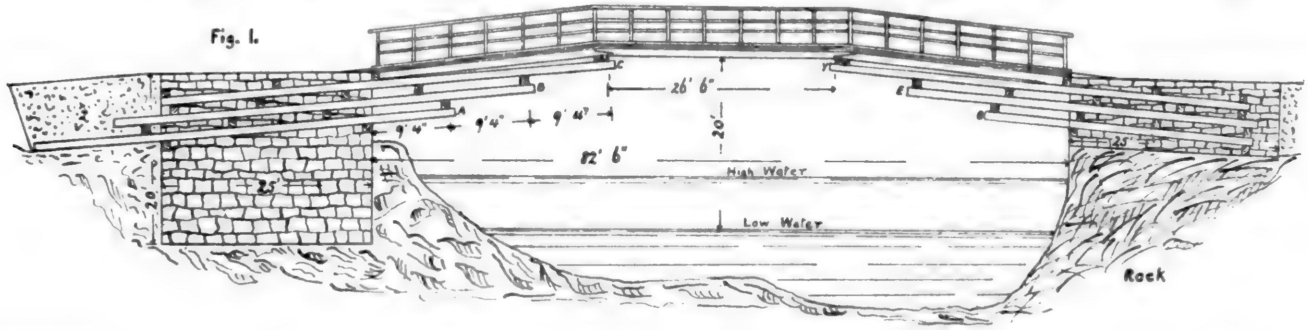
This hammer, until very recently the largest in the United States, is well designed, of great solidity of construction, and admirably made. Its wide base secures it perfect stability. It serves admirably for the forging of heavy ingots up to 1.400 meters in diameter, and also for the working of all large and heavy pieces. The construction of this tool did great honor to the engineers who designed and built it.

(TO BE CONTINUED.)

AN INDIAN CANTILEVER BRIDGE.

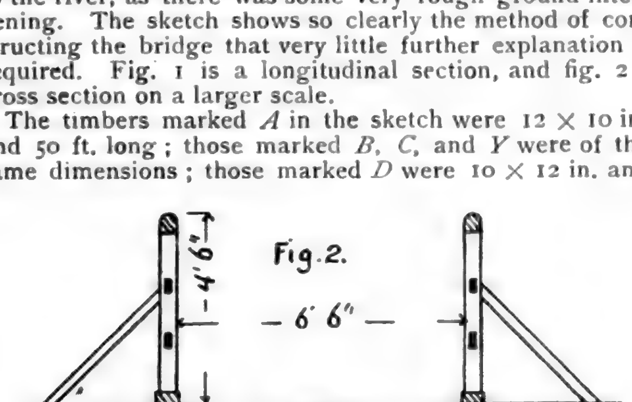
THE accompanying sketch, taken from *Indian Engineering*, shows a cantilever bridge of wood, built after the native method, on a highway road crossing the Rahi River at Pompoo in Sikkim. This kind of bridge is very easily put up if large timber is available, and the only difficulty encountered in the present case was in hauling the long beams from the point where they were cut from the trees to the river, as there was some very rough ground intervening. The sketch shows so clearly the method of constructing the bridge that very little further explanation is required. Fig. 1 is a longitudinal section, and fig. 2 a cross section on a larger scale.

Fig. 1.



The timbers marked A in the sketch were 12 × 10 in. and 50 ft. long; those marked B, C, and Y were of the same dimensions; those marked D were 10 × 12 in. and 32 ft. long, while those marked E were 10 × 12 in. and 42 ft. long. The cross beams were all 10 × 12 in. in section. The battens on which the floor planking is laid are 2½ × 4 in. in section, while the planking itself is 2 in. thick. The posts for the hand-rail were 4 × 4 in. stuff, the top rail being 3 × 5, and the lower rails 2½ × 3½ in.

Fig. 2.



The bridge was put up at high water, but no scaffolding or false-work was required. The wood used for the large timbers was an Indian wood, called *Sal*.

As showing how unchanging methods are in that part of the world, it may be of interest to compare this drawing with the engraving of an Ancient Cantilever Bridge, which was published in the JOURNAL for June, 1888, page 269, which shows that this type of bridge as used in that country is substantially the same now as it was over 200 years ago.

NOTE ON MOUNTING EMERY-WHEELS.

(From the *Revue General des Chemins de Fer.*)

GRINDSTONES or emery-wheels for finishing up parts of machinery, the fitting of which does not require the use of machine tools or hand-fitting, are now very extensively used in railroad shops. The speed at which they are run is necessarily very high, and must still be so chosen that they can resist the action of the centrifugal force; but on account of the unknown and often very variable degree of cohesion in these stones, it is impossible to be certain when we reach or pass the limit of their resistance. The careful inspection and trial always given before a stone is put in use are not sufficient to give all the guarantees which are desirable against an explosion, and it might be said that this very convenient and economical tool is always capable of becoming dangerous at any moment. Generally, in order to avoid the injury which might be done by too great a speed, the stone is run on its trial only at the highest speed which is to be used in service. This is the course usually taken in the shops of the Northern Railroad of France, where, as an extra precaution, a stone which has been tried and passed is again examined with care after it has been used for several hours. On one occasion, in October, 1884, a grinding-wheel of emery, 1 meter in diameter and 0.20 meter in thickness, exploded during the trial after running for 18 minutes, and the pieces thrown off injured the frame and also the main pulley.

In order to prevent the occurrence of similar accidents, there was put up at the La Chapelle shops of the Northern Railroad in January, 1886, an emery-wheel of bi-conical shape, which is shown in the accompanying illustrations, fig. 1 being an elevation, with a portion of the frame broken away to show its section; fig. 2 a plan, with a section of the wheel; and fig. 3 a half cross-section and half end-view.

The diameter of the wheel is 1.200 meters, and the thickness at the circumference 0.200 meter; the lateral faces of the wheel, instead of being planes, as usual, have the form of cones with a very obtuse angle, so that the thickness at the center is 0.230 meter. This wheel is centered upon the shaft, and is then clamped in the ordinary manner between two iron plates, which bear upon it only through a ring 10 centimeters in width, with a felt washer placed between the stone and the plate.

The result of this conical form of the wheel is that in case of a breakage following radial lines—and breakages almost always take place in this way—the fragments are not thrown off, but are held between the plates, to which there is given for greater safety a large diameter, in the case described two-thirds that of the wheel. When the wheel is worn down to a certain degree, these plates are replaced by others, somewhat smaller but having the same conical form, and this permits the limit of wear of the

wheel itself to be reached; by a change of the driving pulley, made at the same time as that of the plates, the speed of the circumference of the wheel can be kept the same.

Three emery-wheels like that which we have described have been used without requiring any special remark; a fourth one broke on trial, May 15, 1888, after having turned a little over one minute. The cracks or breaks were all on radial lines, and the pieces of the wheel, five in number, were held in place by the iron plates; they only received a slight sliding motion of two centimeters. The largest piece was almost exactly one-fourth of the weight of the whole wheel—about 130 kilos.; the centrifugal force

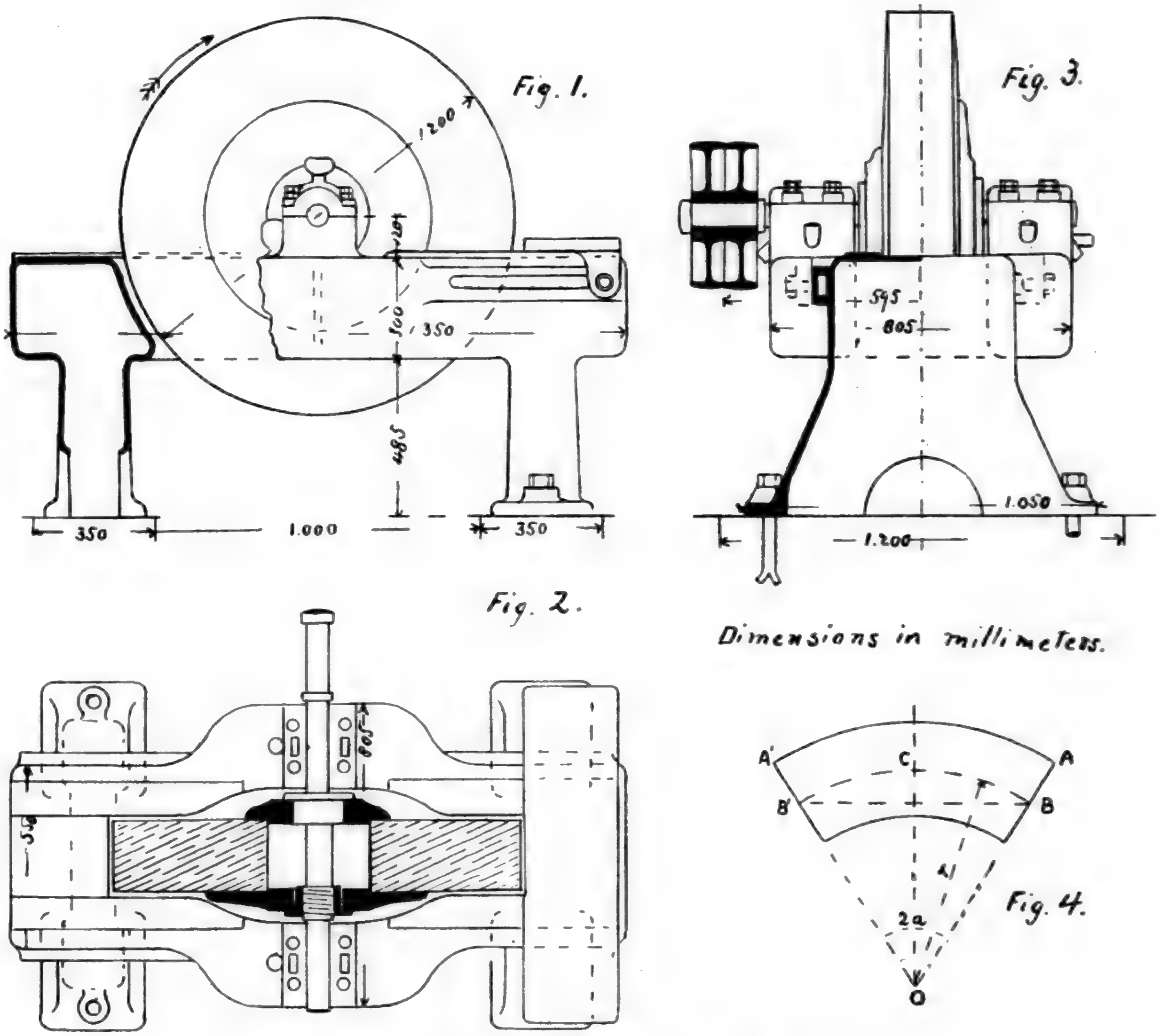
$$r = R \times \frac{\text{Chord } B\,B'}{\text{Arc } B\,C\,B'} = R \times \frac{2\,R \text{ sin. } a}{2\,a\,R} = \frac{R \text{ sin. } a}{a}$$

The value of the centrifugal force then becomes:

$$F = \frac{P\,a}{g\,\pi} \times \frac{x^2\,R \text{ sin. } a}{a} = \frac{P\,x^2\,R \text{ sin. } a}{g\,\pi}$$

In this expression sin. a is the only variable. The maximum value of F is then reached when sin. $a = 1$ —that is, when $2\,a = 180°$.

On account of this considerable force and of the com-



FRENCH METHOD OF MOUNTING EMERY WHEELS.

was calculated at 7.800 kilos. The intensity of this force on a fragment of the wheel would increase with its volume, and would be a maximum for one-half of the wheel, which would constitute the most dangerous piece. The centrifugal force would be then 10.800 kilos., if we admit that there was no radial friction between the sections at the moment of the rupture.

This can be easily demonstrated. A fragment of stone having a mass m, and bounded by the two planes $O\,A$, $O\,A'$ (fig. 4), is acted upon by a centrifugal force $F = m\,x^2\,r$, in which expression x is the angular speed and r the distance of the center of gravity of the fragment from the axis of rotation. If we designate by $2\,a$ the angle $A\,O\,A'$, and by P the weight of the stone, we have:

$$m = \frac{P}{g} \times \frac{2\,a}{2\,\pi} = \frac{P\,a}{g\,\pi}$$

Then let R be the radius of the circle passing through the center of gravity of the fragment, and we have:

pressibility of the washer of felt or soft paper, which must be placed between the stone itself and the iron plates in order to distribute as uniformly as possible the pressure of these plates, it would be better to adopt a more pronounced conical form and to make the plates thicker than those chosen for the present mounting, in order to avoid all danger of bending. They would then resist still more the radial force of the fragments of the stone, which was produced on the trial mentioned above, and which, if it had been more pronounced, would have caused the fragments to strike against the frame and to produce additional breakages, which might have resulted in serious accidents.

By the use of this system of bi-conical stones mounted with care, and by considering the observations which we have presented, all serious danger and injury during the trials of a stone may be avoided and almost complete security obtained in its working.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Professor C. D. Jameson.

CHAPTER I.
INTRODUCTORY.

The Railroad Engineers of to-day may be divided in regard to their duties about as follows :

1. Locating Engineers.
2. Construction Engineers.
3. Engineers of Permanent Way.

The line of demarkation between these three classes becomes more sharply drawn each year, and the change from one class to either of the other two becomes more difficult. The whole tendency of the age is in this, as in everything else, toward *Specialization*, by which the railroad companies and the engineering profession are the gainers.

These three classes of engineers come directly in contact with railroad companies during the different stages of development. Their various duties may be stated as follows :

The *Locating Engineer* has charge of all Reconnaissance, Preliminary Work, and Final Location. He establishes the grades and is responsible for the proper making of the plans and profiles. He must also furnish a Preliminary Estimate of the cost of construction, with a list of all the structures that will be needed, such as bridges, trestles, culverts, etc., with their probable dimensions and cost. These structures are only designed in a most general manner by him, no regard being paid to the details. The only object is to get a sufficiently accurate estimate of the probable cost.

After the line has been finally located, the plans, profiles, and estimate of cost made, the work of the Locating Engineer is finished.

From that point the *Construction Engineer* takes charge of the work. The duties of the Construction Engineer, either directly or indirectly, are not only to superintend the building of the road and of all the structures that are needed, but in the case of temporary structures or structures of secondary importance to design them in every detail.

In the case of primary structures, such as iron bridges, viaducts, etc., the designing and building of these is usually placed in the hands of specialists in this particular class of work.

This is as it should be, for the following reasons : First, that the Construction Engineer as employed upon our American railroads has not the time at his disposal that is required to make a proper design of any elaborate structure, and second, that a man that is in every way fitted to perform in a most satisfactory manner the duties of a construction engineer in all probability is not fitted by either education or training for the designing of large structures in iron or steel.

But there is a large class of structures not only the erection but the designing of which in all their details comes in the hands of the Construction Engineer, such as road-crossings, small culverts, cattle-guards, water-tanks, small stations, and so on up through wooden trestles and wood-and-iron bridges. Such structures as these have to be designed in every detail by the Construction Engineer, are built under his supervision, and erected by him.

It therefore becomes eminently necessary that he should have a thorough understanding of the necessities of such structures and be in every way capable of making such designs as are required ; be able not only to design structures that shall have sufficient strength to bear up any possible load that may come upon them, but also that he shall be able to get a maximum amount of strength from a minimum amount of material used. The same may be said of the Engineer in charge of the Permanent Way. Although the road is supposed to be complete when it comes into the hands of the Department of Permanent Way, still in a majority of cases, in this country at least, it is far from being finished, and many of the structures upon it are only temporary structures, which it becomes necessary to replace in a few years. When they are replaced the new structures are supposed to be improvements on the old ones, both as to the strength and economy of material used. Thus the Engineer of Permanent Way must of necessity understand the designing of ordinary wooden bridges and other structures that come in his way.

Of course the use of wood in railroad construction is diminishing year by year as the price of iron and steel decreases, but with all this decreased cost of metal it is still true that from 50 to 70 per cent. of all the bridges built in the United States each year are built of wood, and designed and erected by the engineers on the road ; and for many years to come this is sure to be the case on all the new roads that are liable to be built in this country. Wood is nearer at hand and more convenient to get at than iron and steel. The first cost of wood is much less, it can be used with much greater rapidity, and it has many other advantages which will insure its use.

In the engineering literature of to-day innumerable books can be found treating in a most exhaustive manner the subject of iron and steel structures of every dimension, from the smallest plate or flanged girder up to the largest cantilever or suspension bridge probable. This is all very well and as it should be ; but there is no book from which a young engineer or an engineer engaged in actual work upon a railroad can obtain the data necessary for building, in an economical and approved manner, the ordinary wooden structures met with on every mile of railroad in this country.

Thus we come to the definite object of this book—to furnish to the engineer in actual work, and to the bridge foremen and superintendents of bridges and buildings on our railroads, data of sufficient accuracy and detail to permit of their building at once any of the ordinary structures that they are liable to be called upon to furnish. The Author claims nothing original in the plans which will be presented. They are only chosen from a large collection of standard plans of most of the leading roads in the country, the Author simply having taken the liberty of selecting such plans as in his opinion appeared the best, and possibly in some cases making such alterations as would reduce the cost of the structure without reducing in any way its efficiency.

These plans are given in all the details necessary for the actual building of the structure. Every detail is fully worked out, and appended to each plan is a complete bill of material of everything that can be needed in the construction.

Particular attention has been given to the subject of Trestles, as it is by far the most important and most general use to which wood is put upon American railroads, and it will undoubtedly continue to be used in this form long after it has been discarded in bridges, from the fact that many of the serious objections to wooden bridges do not apply to trestles.

Besides railroad engineers and bridge foremen, for whose use this book is especially designed, there is also another large and rapidly increasing class who, it is hoped, will find it of great use, and that is the class of young engineers or students who are preparing themselves for regular work. In all our technical schools too much time is spent upon the designing of details and the study of the construction of tremendous cantilever and suspension bridges. Not one out of a thousand of the students who graduate as engineers will ever be called upon to build structures of this vast size.

While it is all important that in order to round out and finish their preparatory engineering education, they should thoroughly understand the principles upon which the construction of such bridges is based, still it appears to the Author that in spending a whole year or more in studying out the details much valuable time is wasted, and the student gets very little benefit from it. The course of engineering, as taught in our American schools, is at the most only four years in length. The students enter the course with no better, and often with much less preparation than is required for an ordinary scientific or classical course.

At the end of the classical course the student then enters a law or medical school, as the case may be, and studies

his profession for two or three years. At the end of that time he is considered fit to become either a doctor or a lawyer, thus having put some seven years into acquiring his knowledge, while in the Department of Engineering four years is the limit, and at the end of that four years the student is expected to have acquired not only a good general education, to be well grounded in all subjects of general information, but also to have completed in as thorough a manner as possible a special course in Engineering. In order to do this in a satisfactory manner it increases by 75 per cent. the amount of work that must be done each year by the student, and it also devolves upon the instructor to use much care in eliminating from this course anything that can, without loss to the student, possibly be postponed until after he is in actual practice, in order that the many points and principles which it is absolutely necessary that he should know, in order to be able to take up his work as soon as he graduates, should be thoroughly understood. One of the points which the Author thinks can be omitted without loss to the student is the spending a year or more in the actual designing, in all its details, of a cantilever or suspension bridge of such gigantic size that it would probably never be built in practice, and certainly never under the supervision of a student just graduated. No matter how much time the student puts upon such work, it always contains more or less radical defects which would rule it out entirely from all practical use. In designing iron and steel structures a certain familiarity with the actual working of the material is absolutely necessary in order to make the design of any value. Therefore, after the student has mastered the general principles and theory upon which the designing of such structures is based, let him drop the structures until after he has graduated.

But there is a class of work the detailed designing of which should be thoroughly understood, and that is the use of wood in all its forms upon railroads. The student must not only have a broad foundation upon which he can build up any special branch of engineering that he may choose after he graduates, but he must also know enough of the practical details of work to make himself of some value to any railroad company that desires his services. Otherwise, he will never be able to retain a situation. And as the material which he will handle in the employ of any railroad company as soon as he gets into the Construction Department or Department of Permanent Way will be wood, or wood and iron combined, in small structures, much time should be spent in studying the plans of these structures and thoroughly grounding the student in all the details connected with their design and erection. There is a constant cry from the chief engineers of the railroads in this country that the graduates from our best technical schools have absolutely no idea of a practical application of the principles which they have been studying during their four years, that they are full of theory, or, in other words, have their hands full of tools about the use of which they know nothing. The Chief Engineer of one of our best Western roads remarked to the Author that "he had never found a graduate of an engineering school who with sufficient time had not sufficient mathematics and theory to permanently locate the position of a star, but he also found very few who had sufficient practical knowledge or common sense to locate a switch or a curve." And this is very much the case.

This book is written, then, as much for the student as for the engineer in practice. By a careful study of its pages it is hoped that he will get a thorough understanding of all the details of any structures which he is liable to be called upon to build, certainly within the first 10 years after his graduation. If the time ever comes that he is called upon to span the Mississippi or the Hudson, it will be so far distant from his college days that he will have had plenty of time to perfect himself in the knowledge necessary for the proper consummation of the work.

CHAPTER II.

FENCES.

In most parts of the United States, and, in fact, in most parts of the civilized world, the railroad companies are required by law to construct and maintain upon each side of their line of road, usually upon the lines of their right-of-way, some class of fence, of such a character as will prevent any live-stock that may be running upon the adjacent land from crossing the track or in any way impeding the free passage of trains, on account of the great element of danger introduced thereby.

The class of fence that can be used is not, in many States, left to the discretion of the railroad companies, but there is a State law definitely designating exactly what manner of fence shall be used. In other States the law merely requires that the fence shall be suitable and in every way answer the purpose for which it was intended.

There are only two classes of standard fence used to any great extent by railroads in this country. These are the ordinary Board and Post Fence, Plate I, fig. 1, and the Barbed Wire Fence, Plate I, fig. 4.

The following are the disadvantages connected with the use of the ordinary post and board fence: First, the cost of the fence, the excessive amount of lumber needed in its construction, and the time it requires for its construction. Second, that being entirely of wood its life is limited, and in a very short time it has to be entirely renewed. There is also a great danger of its being consumed by fire occasioned by sparks from the passing locomotives. The last objection to the board fence is the obstruction to the passage of winds which in countries subjected to heavy snows always causes the snow to drift exceedingly. Where it occurs at the top of cuts and other similar places it is liable to be a cause of great annoyance to the road during the winter season.

These constitute the principal disadvantages connected with its use. As a means for the prevention of the passage of live-stock it is, of course, a perfect success.

During the last five or ten years this post and board fence has been superseded, to a great extent, by the barbed wire fence, and the advantages possessed by the barbed wire fence are very evident, and are as follows: First, the rapidity with which it can be constructed, the time required being less than one-third that required for post and board fence. Second, the exceedingly slight cost of material used. Third, the durability. The length of life of the barbed wire fence depends almost entirely upon the life of the posts. If care is taken when selecting the wire to choose wire of soft material and of sufficient elasticity not to be affected by the expansion and contraction due to changes of temperature, and also wire that has been properly galvanized, there is almost no limit to its durability as a fence. It practically offers no resistance to the free passage of the wind, thus doing away with all the objections arising from this cause, and which are so prominent in the post and board fence.

In its first introduction, however, the barbs upon the wires were made very sharp, and owing to the fact that the fence is invisible to stock until they run against it, many valuable animals were very seriously injured and cut by it.

To such a great extent was this the fact in some States, that it led to the establishing of State laws prohibiting its use in certain localities, and aroused much prejudice against it upon the part of stock breeders living upon the line of railroads where it was used. This prejudice, however, has been done away with, to a great extent, at the present time. In the first place, people are becoming accustomed to its use, and also the barbs on the wire, as now manufactured, are not sufficiently sharp to seriously injure any stock running against it.

Plate I, fig. 4, shows two methods of construction of the ordinary Barbed Wire Fence.

In order to do away, to a certain degree, with the fact that the fence is not readily seen by stock until they run against it, the top strand is very often removed and replaced by a piece of scantling, as shown in the right hand of the drawing. This renders the fence perfectly visible to the stock, and only increases the expense to a slight extent.

In the ordinary board fence, as shown in the drawing, the posts should be about 7 ft. long and 6 in. in diameter. The bark should be removed, as it very soon dries and becomes a great element of danger from fire. In order to obtain the best results with the ordinary post and board fence, the post-holes should be excavated to nearly their full depth and the earth thoroughly tamped around the posts after they are set in position.

ST. J. & I. R.R.

No. 1.

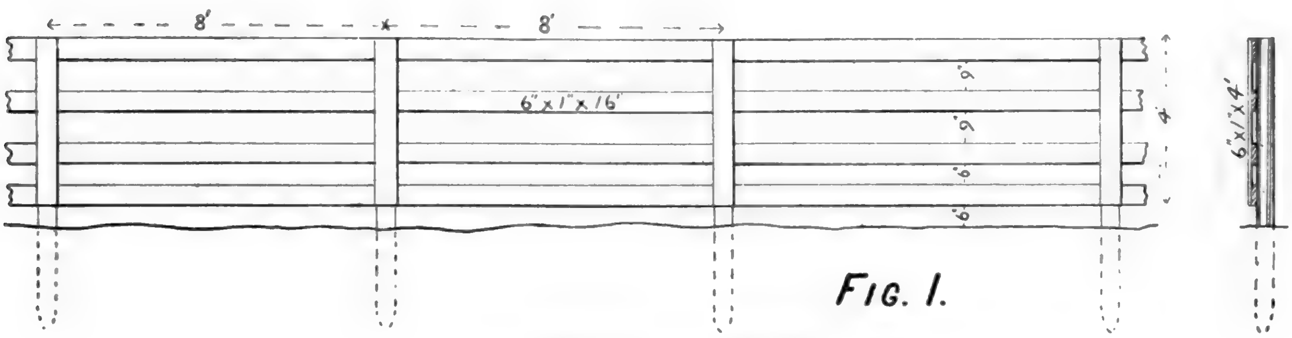
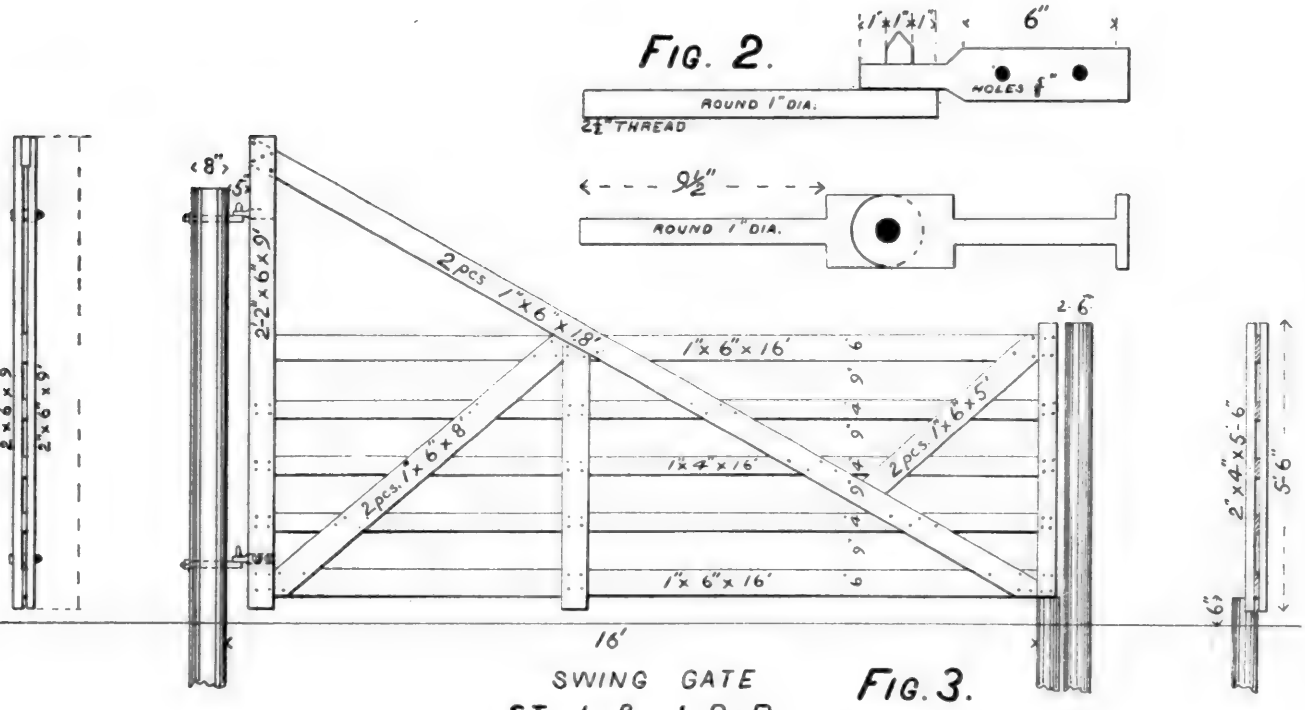


FIG. 1.

BOARD FENCE

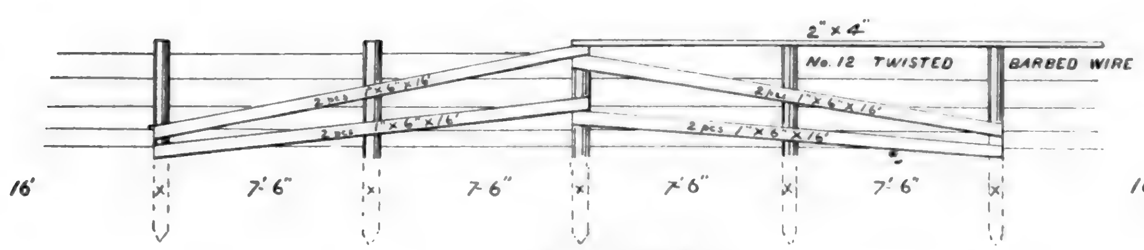
FIG. 2.



SWING GATE

ST. J. & I. R.R.

FIG. 3.



WIRE FENCE

C. M. & ST. P. R.R.

FIG. 4.

The posts should be 8 ft. apart from center to center, as the standard length of the boards is 16 ft.

On most roads, however, it is the custom to simply point the posts and drive them by means of a heavy maul to the required depth, and perhaps a compromise between these two methods would be the most economical as to the time and the stability of the posts—that is, excavate the post-hole one half the required depth, then drive the post the remainder of the distance, and tamp the earth solidly around it.

The boards should always be fastened upon the field side of the posts, in order that the posts may take any strain due to stock running against the fence, and not throw this strain upon the nails by which the boards are held.

Upon the outside of the fence it is usual to put a piece of batten 1 in. × 6 in. × 4 ft. over the ends of the boards, and nail directly through this into the posts. This only adds slightly to the cost of the fence and increases its durability very much.

The ordinary height for a board fence is 4 ft. 6 in. from the ground. The first board, as shown in the drawing, should be at least 6 in. from the ground, the space between that and the second board 6 in., and the other spaces greater—about 9 in. The object of this is to prevent the passage of small live-stock, in the shape of pigs, etc., through the fence.

The following is a bill of material required for the construction of one mile of ordinary post and board fence:

No. 1. Bill of Material, Board Fence, 1 Mile.

660 posts.
1,320 boards..1 in. × 6 in. × 16 ft...10,560 B. M.
660 battens...1 in. × 6 in. × 4 ft... 1,320 B. M.
250 lbs. nails.

Another advantage connected with the use of the barbed wire fence is the fact that the posts need be no nearer than 16 ft. from center to center, thus requiring for a given distance only half the number of posts required for an ordinary post and board fence. This distance of 16 ft. should always be adhered to when possible, from the fact that if from any reason it should become necessary to replace the barbed wire fence by an ordinary post and board fence, then these posts could be used and the others simply introduced in the spaces between, making the panels 8 ft. long, while if they are put 9, 10, or 12 ft. apart, they are not properly spaced for the ordinary boards that are 16 ft. long.

As shown in the drawing, about every quarter of a mile the posts should be braced by means of two braces each way, 1 in. × 6 in. × 16 ft. long.

After the posts have been put in the ground, the manner of constructing the barbed wire fence is simply by fastening all the wires to one of the posts that are braced and then stretching them, by means of a properly constructed wrench, tightly from post to post, and fastening them.

The height of a barbed wire fence is about the same as the ordinary post and board fence, and five strands should always be used, unless a piece of batten is used for the top, when four strands are sufficient.

The strands of wire coming near the bottom should be placed nearer together than at the top, for the same reason that the boards in the post and board fence are nearer together at the bottom.

Although in some sections the prejudice against barbed wire fences is still very strong, there is no doubt that, as the price of wood increases and the price of barbed wire decreases, barbed wire, or some class of metal fence, will be the fence of the future.

As was said before, the life of a barbed wire fence, or any metal fence, depends to a great extent upon the life of the material that is used for the posts, and thus much more money can be economically spent in obtaining good cedar posts for the barbed wire fence than would be justifiable in the ordinary post and board fence.

In some parts of the West experiments, to a very limited extent, have been made with a view to using posts made of terra cotta. Provided the posts could be made sufficiently strong to bear the cross strain that may come upon them, and still light enough to be easily handled, it would present an almost ideal fence post, from the fact that terra cotta is practically indestructible, as far as climatic influences are concerned. As yet, these experiments have been carried to such a slight extent that we are not in any way able to judge what the ultimate results may be.

Through England and in many parts of Europe the fences along each side of the railroads are replaced by means of well-kept hedges. These hedges, of course, are very effective in barring the passage of stock, and also from a picturesque standpoint; but they require constant care, take up a great deal of space, and from a practical standpoint are no better than the ordinary barbed wire fence, so that there is very little probability of their ever being introduced to any great extent in this country, although at present upon some of the Eastern roads they have been used to a slight extent in connection with small stations, but only carried a short distance each side of the station, and used purely for the purpose of ornamentation in connection with flower-beds and lawns that have been laid out at many of these stations.

The following, No. 2, is a complete bill of material for the building of one mile of standard barbed wire fence with five strands. No. 3 is a bill of material of a barbed wire fence of four strands with wooden rail at the top; and No. 4 is a bill of material for the standard Swing Gate, as shown in the drawing.

No. 2. Bill of Material, Wire Fence (5 Strands), 1 Mile.

338 posts.
32 pcs.........1 in. × 6 in. × 16 ft. 256 B. M.
26,400 ft. wire..0.8 lb. per ft........21,120 lbs.
70 lbs. staples.
7 " 10d. nails.

No. 3. Bill of Material, Wire Fence (4 Strands and Wooden Rail at Top), 1 Mile.

338 posts.
32 pcs.........1 in. × 6 in. × 16 ft. 256 B. M.
320 " ....2 in. × 4 in. × 16 ft. 3,520 B. M.
21,120 ft. wire..0.8 lb...............16,896 lbs.
60 lbs. staples.

Plate I, fig. 3, shows the ordinary Swing Gate. This gate is always built of wood, no matter what class of material is used for the construction of the fence. The principal thing to be considered in building a gate is that the hinge-post should be firmly set in the ground, in order to do away with all danger of sagging upon the part of the gate. This form of gate shown, which is the standard upon the St. Joseph & Iowa Railroad, is no more expensive and much more durable and satisfactory in every way than the ordinary farm gate, where the hinges are only placed about 4 ft. apart, cutting off the hinge-post at the height of the fence. The increased expense incurred by running up the back of the gate to 9 ft. and thus increasing the bearing upon the hinges is very slight, and is more than compensated by the increased stability of the gate.

The following is the bill of material for one gate, as shown in Plate I, fig. 3:

No. 4. Bill of Material, Swing Gate.

1 guard rail for hinge post
and snubbing post.......6 in. × 8 in. × 16 ft.
1 fence post for latch post..10 ft.
2 pcs.....................2 in. × 6 in. × 9 ft.
2 " ....1 in. × 6 in. × 18 ft.
2 " ....1 in. × 6 in. × 16 ft.
2 " ....1 in. × 6 in. × 8 ft.
2 " ....1 in. × 6 in. × 6 ft.
2 " ....1 in. × 6 in. × 5 ft.
3 " ....1 in. × 4 in. × 16 ft.
2 " ....2 in. × 4 in. × 6 ft.
3 lbs. 40d. wrt. nails.
3 " 10d. " "
1 pair hinges as per fig. 2, with nuts and washers.
4 bolts ½ in. × 6 in. (Machine) with nuts and washers and 1½ in. thread.
1 heavy hook and staple.

Plate I, fig. 2, shows in detail the standard form of hinges to be used upon these farm gates. Any ordinary blacksmith can make them in about two hours' work.

(TO BE CONTINUED.)

THE HURST & TREANOR STONE CAR.

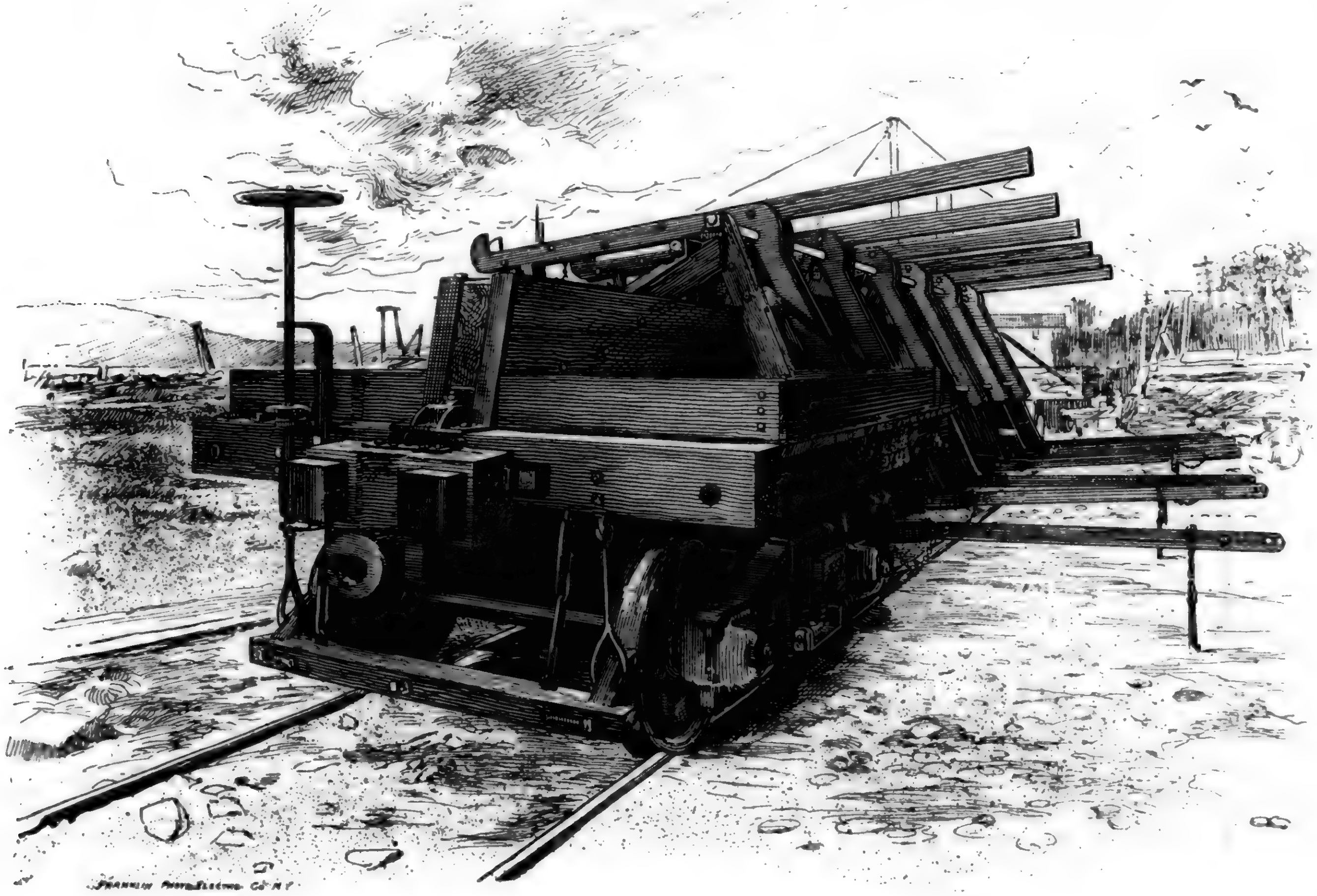
THE accompanying illustrations show a car intended to carry paving-stones of very large size, one of them being taken from a photograph of the car loaded, while the other shows the car empty, exhibiting the method of its construction. This car was designed by Mr. James J. Treanor, of the firm of Hurst & Treanor, blue-stone dealers at Hastings, N. Y., with the intention of overcoming one of the chief difficulties in the way of transporting large stone platforms by rail. On an ordinary flat car no stone larger than 10 ft. in width can be carried, and this size is not sufficient for those now used for sidewalks on the principal avenues in New York, where the preference is for single stones extending from the stoop line of the house to the curb line or outer edge of the walk. This distance is usually 15 ft. 6 in., and stones 15 ft. 6 in. or longer, by 10 ft. wide, have been carried to the city by rail. Many of the larger and handsomer houses in the city, however, have stoops varying in width from 10 to 20 ft. between the newel-posts, and it is always desirable to cover this space with a single stone. Hence the problem arose how to carry a stone 15 ft. 6 in. wide and from 10 to 25 ft. long, when required.

Mr. Treanor made sketches of his plan and submitted them to Mr. William Buchanan, Superintendent of Motive Power of the New York Central & Hudson River Railroad, and under his direction the car was built by Mr. E. Chamberlain, Master Car-Builder at the car shops in East Buffalo.

The car is built with two ordinary standard trucks, set about 35 ft. from center to center, the portion over each truck being framed and floored the same as an ordinary platform car. These platforms are connected by a heavy pine girder 12 × 24 in. resting on top of them, and extending from one end-sill to the other. This girder acts as an immovable beam, serving also as a rigid backbone for the support of six oak triangles, each 6 ft. on the base and about 6 ft. on the perpendicular. These triangles are framed so that they straddle the girder or backbone, their sides extending to the line of the oil-boxes on the car trucks, and their bases coming down to within 14 in. of the top of the rail. Under the bases four truss-rods are strung; the two outer ones are attached directly to the end-sills, and lead down from them to the under side or base of the triangles, having the effect of putting down the ends of the car when the load is in position, and thus preventing sagging. The other two also run under the bases, but are attached to the inside end-sills so that their pull is against the strains of the outer truss-rods.

The triangles carry each at its upper apex a heavy cast-iron cap, and through these caps runs an iron shaft $2\frac{1}{2}$ in. in diameter, extending from end to end of the car. The extremities of this shaft rest on braces built upon the end platforms. This shaft serves as a bearing for straps of $6 \times 1\frac{1}{2}$ in. iron, bent as shown in the accompanying sketch (fig. 3), the lower end of each strap having a hook projection, on which the edge of the stone rests. These straps are placed in couples, with an oak skid 5 × 6 in. bolted between each pair, these skids being flush and parallel with the lower portion of the straps, and extending above them as a support for the top portion of the stone when loaded. The straps are bent at such an angle that when they are placed in position on the shaft—on which they simply hang by the circular slot cut in the angle at *B*—their lower edges rest against the triangles described above. In the horizontal position the straps are bored at their outer ends to permit an iron pin to pass through them and through upright iron rods, which are fastened to the triangles on the side opposite to the load. These upright rods act as braces when the load is top-heavy, and as tie-rods at other times.

To load the car the straps are turned on their bearings until the hooked parts and the skids which are bolted to



HURST & TREANOR'S CAR FOR CARRYING LARGE STONES.

them are in a horizontal position, and are then blocked to prevent them from falling. The stone is then rolled on to the skids until the edge comes against the hooks, the blocking is taken out, and the stone, which is then like the leaf of a table hung in the middle, is lowered until the ends of the skids rest on the triangles. A bar of railroad iron is passed through two eye-bolts which are tightened by turn-buckles until the bar is pressed hard against the face of the stone, thus locking it in place so that it cannot be jarred off the hooks. The car is then ready to be started on the road.

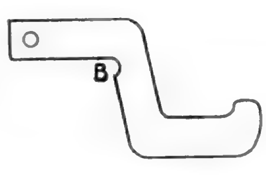
The stone that this car was built to carry was not the largest that ever came to New York, but it was yet the largest by 4 ft. 8 in. that ever came by rail. On this car a stone can be carried 26 ft. long by 15 ft. 4 in. wide without interfering with the tunnels or bridges on the road.

There are several stones in pavements in New York nearly approaching the size given above, notably the three which are in front of the stoops of Messrs. William H., Cornelius and William K. Vanderbilt, on Fifth Avenue.

This special car makes it possible to send these enormous stone platforms to almost any point that can be reached by rail.

The construction of the car, which can be readily understood from the engravings, is very ingenious, and reflects much credit upon its designer. It must be remembered that stones of the size mentioned above are not by any

Fig. 3.



means easy to handle, and that as their cost increases very rapidly with their size, it is of much importance to prevent breakage and carry them safely, as well as to provide means for handling them.

HURST & TREANOR'S CAR FOR CARRYING LARGE STONES.

THE FIRST CHINESE RAILROAD.

THE Kaiping Railroad, which was first opened for traffic in November last, and which is the first railroad in China, is 86½ miles long, extending from the city of Tien-Tsin to Tong-Ku on the Peiho River, and thence to the coal-mines of the Chinese Mining & Engineering Company at Kaiping. A short section of seven miles of this road was built some years ago, from Tong-Ku to the Kaiping Canal, but was very little used, and the whole road is substantially new. It is intended chiefly to carry coal from the mines to the port of Tien-Tsin, but has already developed, it is stated, a considerable merchandise and passenger traffic, although it does not touch any large cities.

The line has been constructed by an English engineer, who has, however, applied much of American practice. The cars are of the eight-wheeled pattern common in this country, built after the American method, and are supplied with Janney couplers. A considerable number of chilled cast-iron wheels have also been used, and there will be a fair opportunity of testing their merits, as they will have to run in practical opposition to wrought-iron wheels with steel tires made in England. The passenger cars are 55 ft. long, and are mounted on two four-wheeled trucks of American pattern, with 42-in. Krupp wheels. The trucks are of iron and steel, the wood-work being entirely confined to the car body.

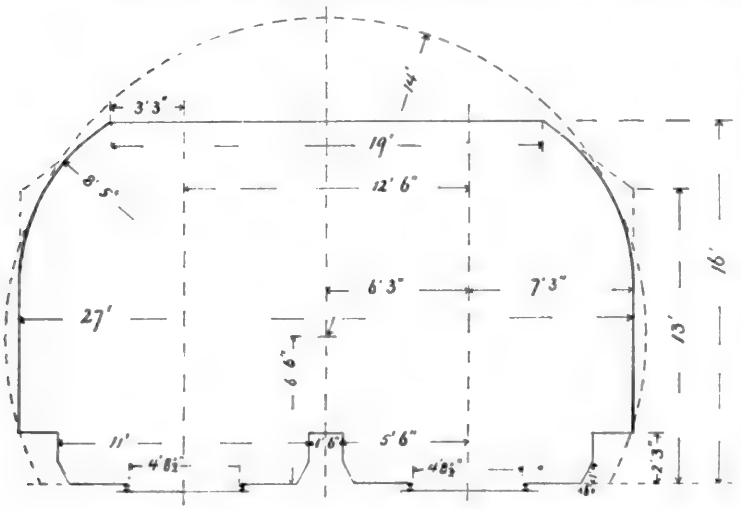
The road has been solidly built, with iron bridges and other work of a substantial character. The rails are of steel, 70 lbs. to the yard, with the ordinary fish-plate, it having been considered best to provide for a future increase of traffic rather than to lay a lighter rail now. A few steel ties were used in the substructure, but the most of the ties are of chestnut brought from Japan, where they are more cheaply obtained than in China. The ballast is of broken stone.

The accompanying sketch is an outline showing the minimum size of structure adopted for the road—that is, the space required for the passage of trains, to which tunnels, bridges, and other structures must conform.

The locomotives so far used, although built in England, follow American design, most of them being of the Mogul pattern; an engraving of one of these locomotives was given in the JOURNAL for January, 1888, page 28. American practice has been followed not only in general design, but in the use of steel fire-boxes and tubes, the only important deviation being in the use of the plate frame instead of our bar frame.

It is said that, although the road-bed is in very good condition, slight accidents have been at first quite numerous, chiefly owing to the carelessness or lack of knowledge of the switchmen, flagmen, and other employés, who are nearly all natives, and probably not yet fully educated to their work.

The estimate of traffic for the first year is: 180,000 passengers, 200,000 tons of coal, 40,000 tons of salt, and



30,000 tons of general freight. It has been thought expedient and necessary to fix rates at a low figure, but it is hoped that the road can be operated for about 50 per cent. of its gross earnings, and that in time it will return a profit on its cost in addition to the advantages it offers as an outlet for the coal-mines.

Three classes of passengers are provided for, after the European fashion, the first-class being provided with a car fitted like an ordinary American day coach; the second-class carried in a plainly furnished car, having a double row of seats running lengthwise, while the third-class passengers have to be seated on rough board seats in an ordinary box car. At present only mixed trains are run, and the speed does not exceed 20 miles an hour; but when business is more developed the company expects to run passenger trains at a higher speed.

This road was built under authority from the Viceroy, Li-Hung Chang. Subscriptions were asked for the stock from Chinese merchants generally, but, probably from distrust in this form of investment, they did not come forward, and the money for building the road was provided by the Viceroy and his subordinates, who subscribed a considerable amount, and by the coal company.

With regard to its effect on future construction of railroads in China, it may be said that the road is not so situated as to form any part of a general system of railroads for the country; but, on the other hand, it is conveniently placed for inspection by the great officials and others, who have their headquarters at Peking. There does not appear to be any official opposition to it at present. There has been some talk of an extension or branch to Peking, but this does not appear probable for some time to come.

AN IMPROVED STEAM PILE-DRIVER.

(From *Industries*.)

DIRECT-ACTING steam pile-drivers have now come into very general use for all works where time is an important element. The pile-driver illustrated herewith is an improvement on steam pile-drivers hitherto in ordinary use, in which the piston-rod and "monkey" are in one, and which of necessity have a stuffing-box at the bottom of the cylinder. In the machine shown the cylinder and monkey are in one casting, and form the movable part giving the blow to the pile, while the piston-rod remains stationary in relation to the pile. The bottom of the monkey being solid, there is no dripping of water from condensed steam on to the pile head. Another advantage in the De Wit pile-driver is that the steam hose or pipe which conveys steam from the boiler to the pile-driver remains stationary during working, consequently there is but little wear and tear. In the pile-driver under notice the piston-rod is fixed to an H iron frame, provided at its lower part with a foot, which rests upon and guides the head of the pile. A recess is cast in the monkey, as shown, to give room for this foot. As the pile descends, the frame, piston-rod, and piston descend with it. Steam is admitted into the cylinder or monkey through the hollow piston-rod and transverse holes immediately above the piston. Both piston and rod are in one forging. The admission and exhaust of steam is controlled by a three-way cock, worked by hand from a rope attached to a handle. The handle could be worked automatically, but this is not considered desirable. The machine is single acting, the cylinder and monkey being lifted by steam pressure, and falling free when the exhaust is opened. The pile-driver, controlled by hand, is capable of making from 30 to 33 strokes per minute, and of driving from 20 to 25 piles per day, according to the nature of the ground. Various sizes are made, the smallest having a monkey of 6 cwt., and the largest one of 30 cwt., the latter being the machine shown in our illustrations. The stroke of this machine is 6 ft. 5 in., and the diameter of cylinder 9½ in. The machine is constructed to drive piles up to 39 ft. 4 in. long. The frame-work is of timber, mounted upon four wheels. The boiler is of the vertical type, 10 ft. 6 in. high by 4 ft. 3 in. diameter, and the steam winch is supplied with two distinct motions, one for lifting the pile into position, and the other for raising the monkey. The total weight of the pile-driver is 7½ tons, and there are 175 cubic feet of timber in the staging. We are informed that these pile-drivers have done good work at Antwerp, Bremen, and Amsterdam. They have also been used on the North-eastern Railway, and are being employed in the construction of the Manchester Ship Canal.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer.*)

(*Continued from page* 24.)

V.—THE HEYDRICH SYSTEM.

THE object of the inventor of this system of interlocking is to reduce to a minimum the number of movements necessary to bring into play the interlocking, using the same lever which works the signals and the switches. With this purpose, M. Heydrich, while using a spring the action of which locks the lever as soon as it is touched, has modified this arrangement in the manner described below.

If we take a lever, *A*, fig. 38, in its normal position (the type is the same for the signals and for the switches), *B* being the sector which guides the movement of this lever, when we reverse it in order to bring it to the position marked A^1, against the working lever is a rod, *t*, which works the lock *V*, which falls into a slot made in the sector, and which must be drawn out of this slot when we wish to change the lever *A* from one of its positions to another; below this lock is a small S-shaped spring, which, when the lever is in its normal position, bears upon a button, *r*, and holds the lock in the slot. If we take hold of the handle *p*, pressing it lightly in the direction toward which the lever should be moved, the rod *t* is thrown down, overcoming the resistance of the spring, and throws the lock out of the slot. At the end of the throw of the lever the spring acts upon the lock in order to throw it up into the other slot. By this arrangement, under which the axis of rotation of the rod *t* and of the

lock V do not coincide with that of the lever A, M. Heydrich avoids the use of the oscillating lever, which is in the Saxby apparatus used to obtain the movement of the slotted interlocking levers.

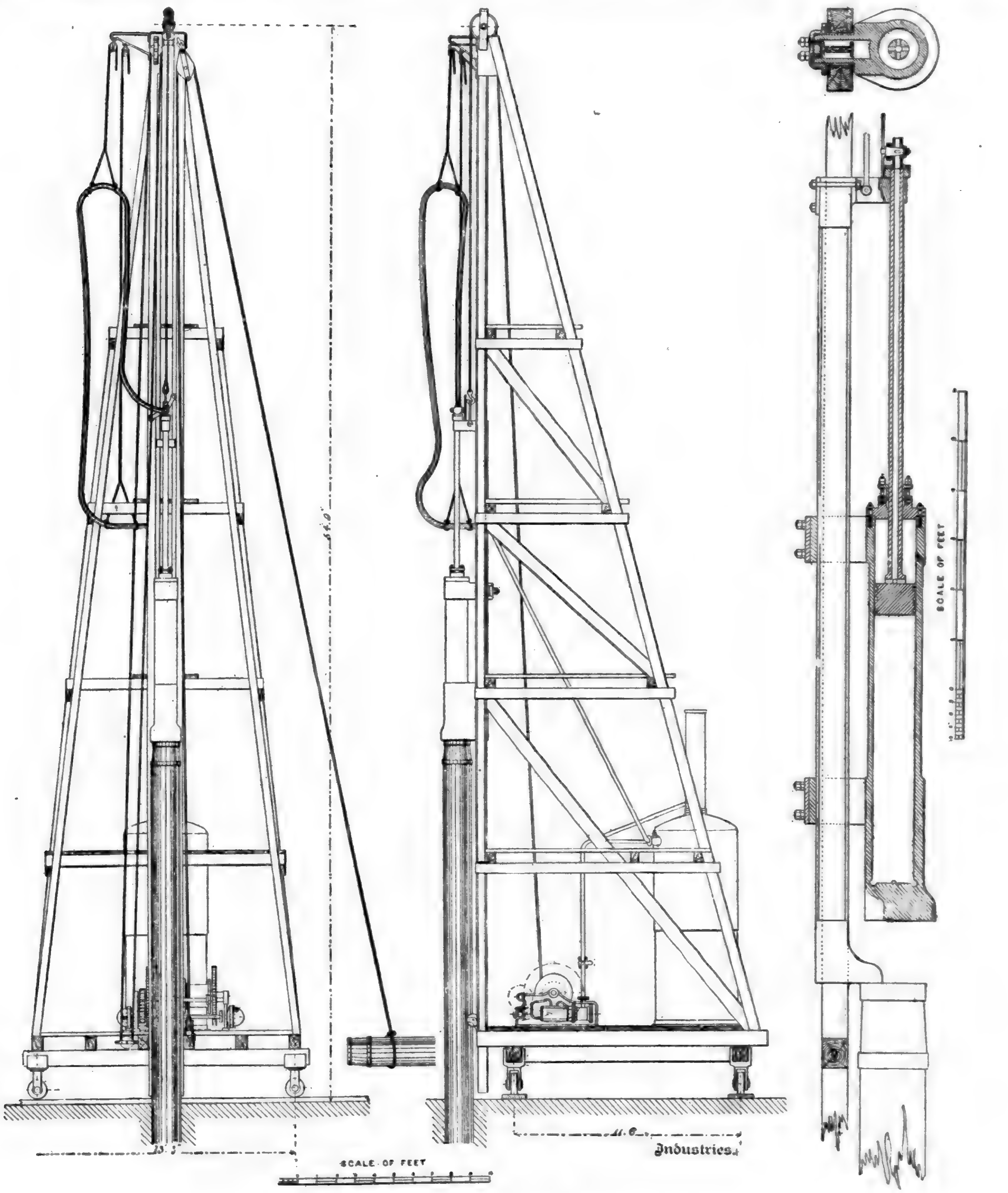
The command of the apparatus of the interlocking table is here given directly by the rod t through a lever b, the free end of which works the two rods i and j; the interlocking arms are fixed to the rod i, while to the rod j are attached horizontal tubes into slots in which these interlocking arms enter, or against the sides of which they bear.

As shown by fig. 40, the interlocking is produced by the rotation of these tubes around their axes, presenting to the interlocking arms either a groove or a plain side, according to their positions.

This apparatus has not a very extended place; it is used generally for small signal cabins, placed in docks and freight-houses; it would not be available for important signal posts in which compound interlocking systems are necessary.

VI.—THE RAILWAY SIGNAL COMPANY'S SYSTEM.

At the Liverpool Exhibition in 1886 there was an interlocking system exhibited by the Railway Signal Company and applied on the Lancashire & Yorkshire Railroad in England, and the Midland Great Western in Ireland. This company has attempted to secure a simplification of apparatus already in use, and has applied for that purpose an arrangement which recalls the Remery-Gautier system, which we have already described (page 20, January num-



IMPROVED STEAM PILE DRIVER.

ber of the JOURNAL), with this difference, that the interlocking arrangement instead of being above is under the floor of the signal cabin.

If we take a lever, *L*, fig. 41, with a spring catch, *p*, working around the axis *O*, and connecting it with the rod *t*, through which a signal or a switch is moved, at the point *i* there is fixed a horizontal bar, *b*, which moves in slides mounted on the interlocking table *T*. Fig. 42 shows in detail the arrangement of these bars, b^1 b^2 b^3 b^4, in which are made bevelled slots working against the blocks *A*, mounted on other bars, m^1 m^2, placed at right

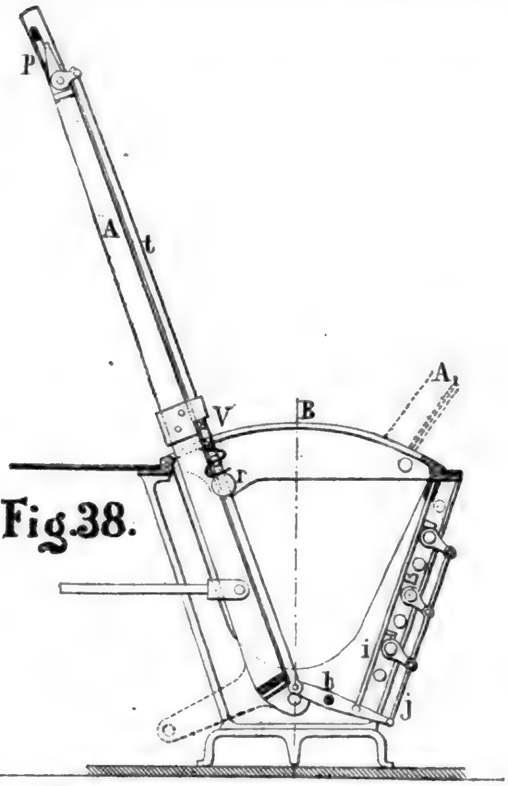


Fig. 38.

angles to the first. We see that when we reverse the lever corresponding to the bar *i* this would be moved, and working upon the block *A* would cause the bar m^2 to be moved in such a way as to force the block A^2 into the slot in the bar i^4, the lever of which is by this action locked; then we have i^1 *R* : i^4 *N*.

This apparatus can be used for a certain number of combinations, but in attempting to simplify it the direct action of the spring upon the lock has been completely dispensed with, which is really a step backward, and which amounts to suppressing the only guarantee of security against the trouble; which might result from an incomplete or partial movement of the levers. We must then inquire whether the economy in first cost which is obtained by this suppression is not more than overbalanced by this drawback. As soon as a small company like those in Ireland reaches the necessity for an interlocking system, it would be well for it to consider whether true economy would not require the adoption of the best system.

VII.—THE GOURGUECHON SYSTEM.

M. Gourguechon has put up at some minor junctions on the French State Railroad System—Parthenay, Loudun, Marcenais, etc.—an apparatus of small first cost and easily maintained, which can be used for elementary interlocking combinations.

There are two types used, as the signal levers to be interlocked are placed side by side or at a certain distance apart.

A case where the two levers are placed side by side is shown in fig. 43, in which L^1 L^2 are the two levers to be locked, placed on either side of the stand *M*, on top of which a bent iron bar, *a b*, is pivoted to the axis *O*. When one of the two levers—L^2 for example—is worked, it strikes against the arm *a*, the bar turns, and the other arm, *b*, is thrown against the opposite lever in such a manner that it cannot be moved.

It may be remarked that the rotation of the bar *a b* only begins when the lever has already passed over nearly half of its course; both levers could then be raised to this half-way position, and cause, under certain conditions of tension of the connecting wires, the simultaneous movement of the two signals which it is intended to lock together. We are, therefore, it will be seen, far from the perfection which can be attained by the use of spring catches.

In fig. 44 we have a case where the signals are placed at a distance apart, and the two levers L^1 L^2 are joined by a chain, *C*—where there are three levers the chain is divided, as shown in the lower part of the cut—but we see that it is impossible to work the levers L^2 L^3 without having loosened the chain by first changing the lever L^1; *vice versa* it is necessary first to throw L^2 and L^3 back to their normal position before we can move L^1. If we adjust the bent iron bar *a b*, we will have an interlocking arrangement between these three levers made in such a way that they can be changed only one at a time, which is the case with *Stop* signals at junctions which do not permit the passage of more than one train at a time, even when no inconvenience could result from it—that is to say, when the signals are not interlocked with the switches and their locks.

For an even number of levers, say four, we would have an arrangement similar to that shown in fig. 45; the working levers of the first pair are joined to those of the second by chains placed crosswise and attached below the first levers to a pin, to which there is also fastened the connection with the signal which is joined to the second pair of levers, at such a distance from the pivot *a* that *a b* = *a c*, —*c* being the point to which are attached the signal connec-

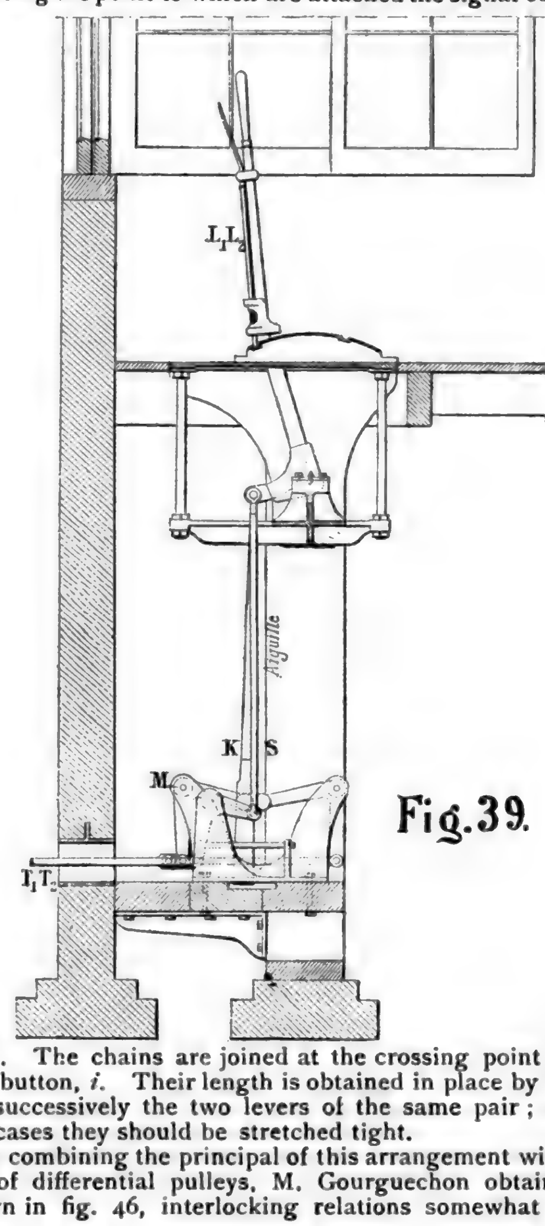


Fig. 39.

tions. The chains are joined at the crossing point by an iron button, *i*. Their length is obtained in place by working successively the two levers of the same pair; in the two cases they should be stretched tight.

By combining the principal of this arrangement with the use of differential pulleys, M. Gourguechon obtains, as shown in fig. 46, interlocking relations somewhat more

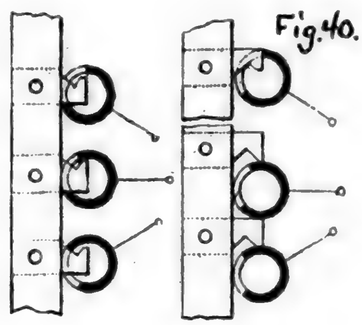


Fig. 40.

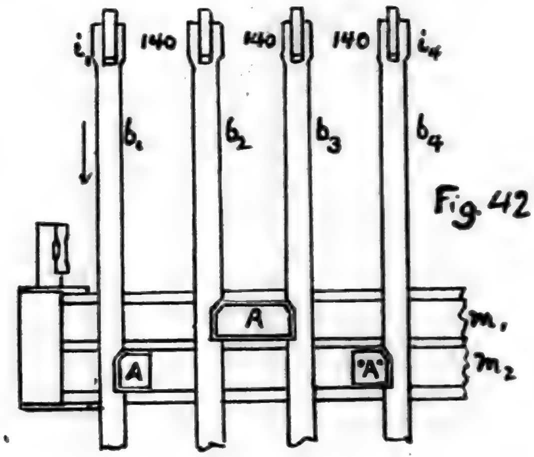


Fig. 42

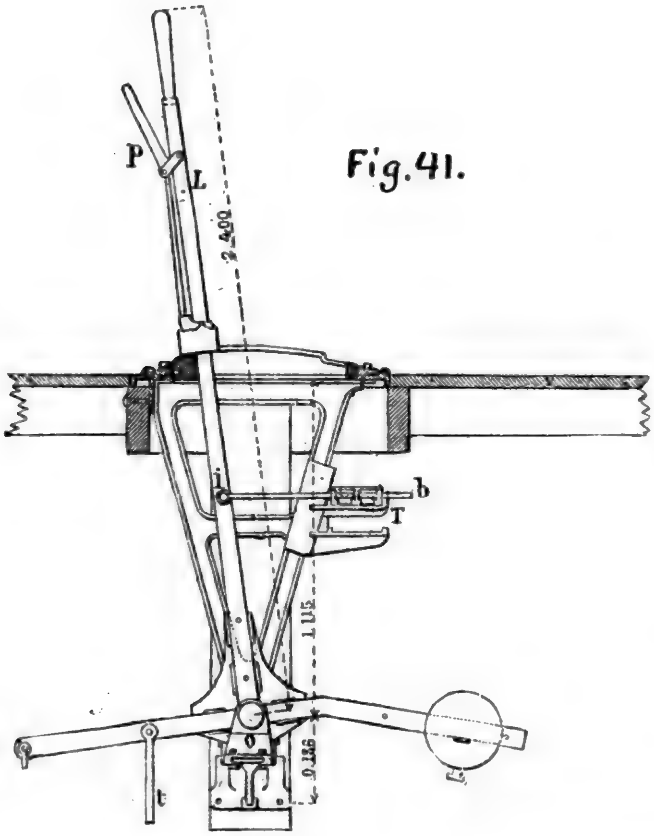


Fig. 41.

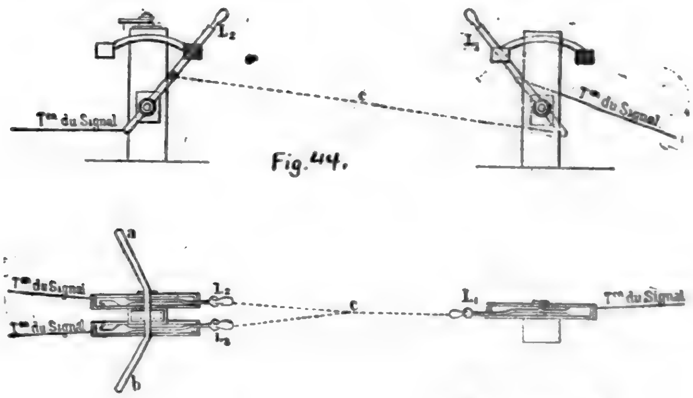


Fig. 44.

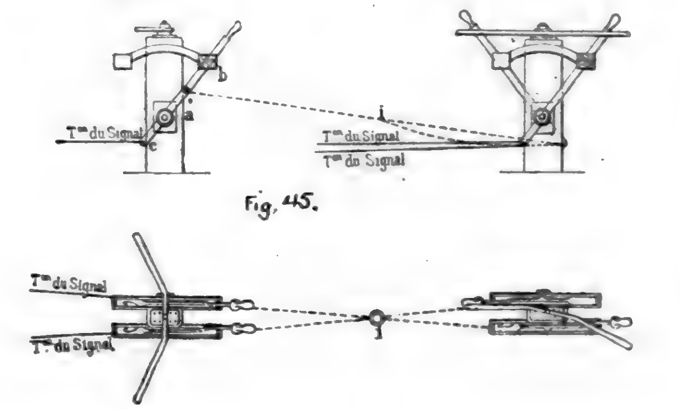


Fig. 45.

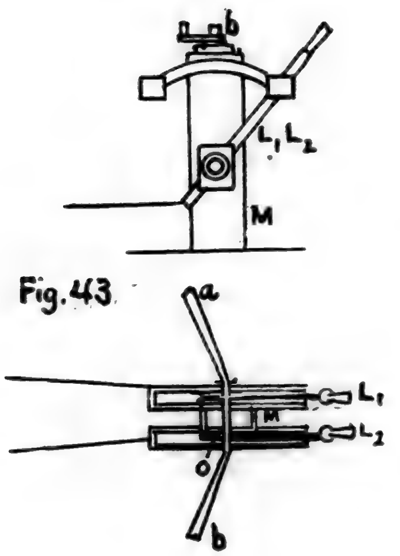


Fig. 43

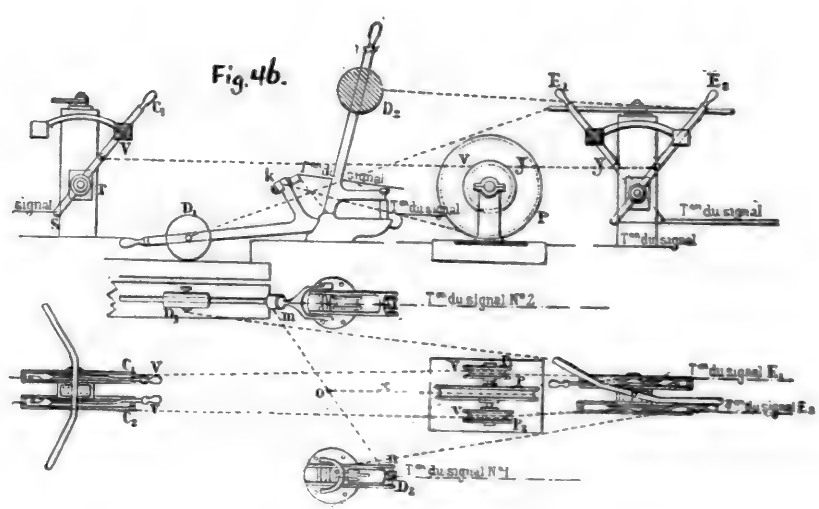


Fig. 46.

complex between junction signals, for instance, and station signals.

The two levers D^1 D^2 working distant signals of the station are joined by a chain, *m m*, at the middle point, *O*, at which is attached another chain, *x*, which works over a pulley, *P*, having a diameter of 0.70 meter, equal to the distance passed over by the point of attachment of the connection beyond its motion for the change of the signal; the chain *m m* is then stretched, and causes the pulley *p* to move.

To the shaft carrying this pulley there are fixed two others, P^1 P^2, having a diameter of 0.30 meter, equal to the movement required for the lever of the signal C^1 at the point of attachment of the chain *V V*, which is obtained by taking $rV = rS$. These chains give to the small pulleys P^1 P^2 a movement directly opposite to that which is given to the large pulley *P* by the levers of the distant signal, in such a way that if we move one of the levers D^1 D^2 we fix the levers C^1 C^2 so that they cannot be moved, and *vice versa*.

Finally, we can join the distant signals E^1 E^2 at the junction to the interlocking system by connecting their levers with small pulleys by other chains, *y y*. The length of all these chains is obtained by putting all the signals in succession at *Line Clear*.

Although this system is not of mathematical exactness, it can be used at many small signal points, on minor lines, to secure at a small expense the interlocking required by the Government regulations of our railroads without the necessity of adopting a more costly apparatus or a cabin of an expensive type.

In fact, it works well at several places where it has been in use, and this is an argument which is not without weight, while that of economy is a very important one for those minor or secondary lines which are just now increasing largely in number.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE most interesting naval event of the past month has been the publication of the plans of the floating battery or coast-defense ship, the construction of which was authorized by Congress over a year ago. It is understood that the general design of this vessel originated with Secretary Whitney, the plans having been worked out in detail in the Department.

For the accompanying cut and description we are indebted to the *Army and Navy Register*.

THE ARMORED COAST-DEFENSE VESSEL.

The principal dimensions of this vessel, as laid down in the plan, are: Length between perpendiculars, 250 ft.; extreme breadth, 59 ft.; mean draft, 14 ft. 6 in.; displacement, 4,000 tons; engines, 5,400 H.P.

The battery will consist of one 110-ton, 16-in. breech-loading rifle in a forward barbette; one 46-ton, 12-in. breech-loading rifle in the aft barbette; one 15-in. pneumatic dynamite gun, and 15 rapid-fire guns—six 33-pounder, three 9-pounder, two 6-pounder, and four 3-pounder.

The bow will be ram-shaped and strengthened for ramming.

The vessel will be constructed on the bracket system, having a double bottom nearly the entire length, extending up to the armor shelf.

The inner bottom and the interior of the hull are divided into numerous water-tight compartments.

There will be a light superstructure above the main deck, extending from barbette to barbette.

The protection of the hull is by a belt of steel armor extending the entire length of the vessel. Over the vital parts of the vessel this belt is 16 in. in thickness, and at the extreme ends it is reduced to 8 in. and 6 in. in thickness.

The armored deck over magazines, engine, boilers, and hydraulic machinery for manipulating the 16-in. and 12-in. guns is 3 in. in thickness, and at the forward and the after ends of the vessel it is 2 in. in thickness.

There is an armored conning tower, 10 in. in thickness, located immediately abaft the forward barbette, in which are fitted the steering gear, telegraphs, speaking tubes, etc. The arrangement for raising and housing the anchors is in accordance with the most modern arrangements.

The vessel is to have a military mast about 20 in. in diameter, and 50 ft. above the superstructure deck, placed abaft the smoke-stack, out of line of fire, for signal purposes, and fitted as an uptake for exhaust ventilation. The mast will have two tops, one fitted to carry two machine guns and one fitted for search light. A steel boom is attached to the mast, to be used as a derrick for working the boats.

The propelling machinery is of the most modern type, and is capable of developing and maintaining under forced draft at least 5,400 indicated H.P. for at least four hours under standard conditions in the smooth-water trial.

The boilers are placed in two independent fire-rooms and using one smoke-stack, the base of which is protected by steel armor 6 in. in thickness.

The vessel will have twin screws of about 10 ft. 6 in. diameter, with such pitch and number of blades as may be deemed best to obtain the requisite speed.

The ventilating, draining, and pumping arrangements are of the most modern character.

Dynamos of sufficient capacity are provided, and of most modern style, for search lights and lighting vessels throughout.

The vessel will be provided with the following boats: One 28-ft. steam whale boat, one 28-ft. cutter, two 26-ft. cutters, two 27-ft. whale boats, one 18-ft. dinghy.

Accommodations are provided for the captain, for at least 16 officers and 150 men.

TRIALS OF NEW VESSELS.

The second trial of the dynamite gunboat *Vesuvius* was had on December 28, on Delaware Bay. She ran over the two-knot course inside of the required time (5 minutes 57 seconds), but was unable to complete the trial on account of the breaking of an air-pump connecting lever, which disabled one of the engines. On the official trial, January 11, the *Vesuvius* showed an average speed of 21.65 knots an hour, the engines developing 4,295 H. P. The course measured 2.54 knots each way.

A preliminary trial of the new gunboat *Yorktown* was had January 2. The run from Cramp's ship-yard to New Castle, 35 miles, was made exactly in 2¼ hours. The run from there to Ship John Light was also very satisfactory. The contractors soon afterward gave orders to let her go over the Government course for the test. At the word of command the engineer started his engines under a full head of steam. The *Yorktown* went over the two-knot course both ways at the rate of 16.8 knots per hour. The first run over the track, going with the tide, was made in 7 minutes 2 seconds; the return against the tide was made in 7 minutes 15¾ seconds. The return trip was made in good time. The engines worked well both with natural and with forced draft.

NAVAL RESERVE.

The question of a naval reserve is again attracting public attention, and steps have been taken in various quarters to urge Congress to take action upon the bill already before it, or some similar measure, which will provide for a naval militia and also for some system by which merchant vessels can be taken for naval use in case of necessity.

A PROPOSED NEW MONITOR.

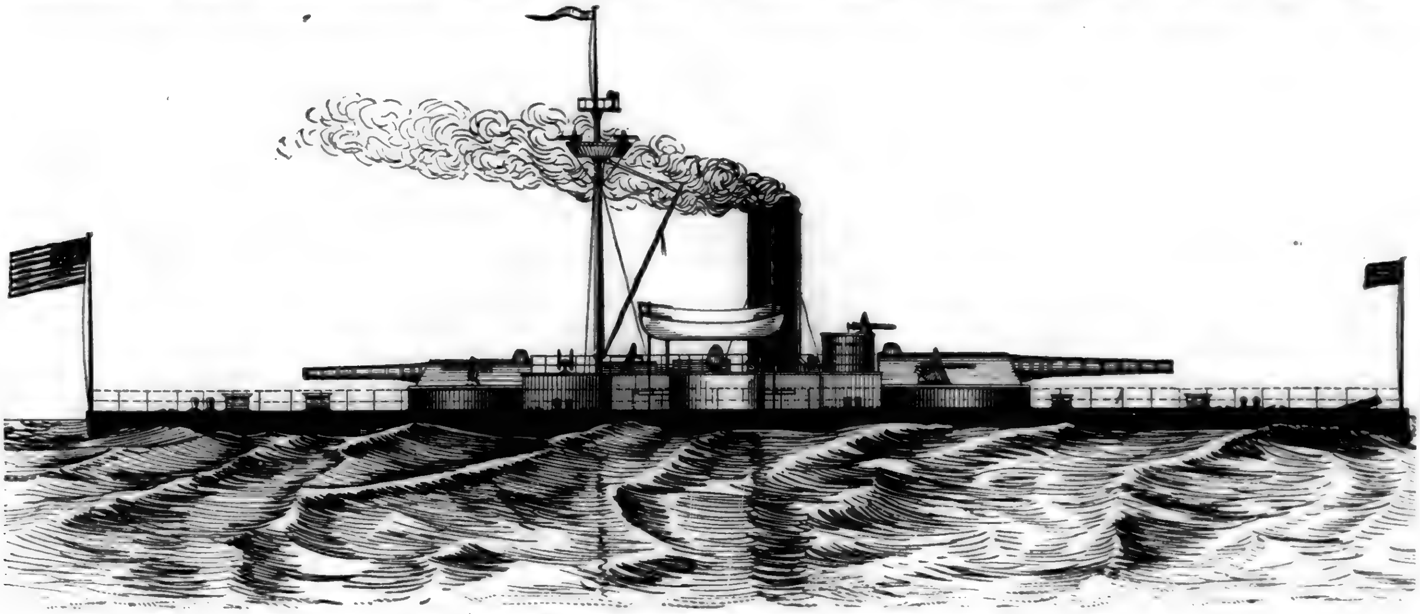
It is stated that the board of naval officers to which was submitted the plan for a novel cruiser, presented by Mr. John R. Thomas, has made a favorable report. This vessel is to be armed with two 10-in. breech-loading rifles. These guns are mounted forward in a turret armored with 10-in. solid steel plates, the axis of the guns, when level, being 11 ft. above the fighting load line. The range of fire of these guns is from directly ahead to 65° abaft the beam on either side, and by removing the deck-house a practically all-around fire is obtained. For closer quarters

she has a 15-in. dynamite gun of the Zalinski pattern, capable of throwing 800 pounds of high explosive compound. She has also two under-water bow torpedo tubes and one 6-in. rapid-firing breech-loading rifle located aft.

To give the greatest armor protection possible on a very limited displacement (3,130 tons), the armor has been disposed in the form of an arc of a circle, turning downward at the sides to 4 ft. below the fighting line. The armor on the crown is 3 in. thick, increasing at the sides to 5 in.

In order that the target presented to an enemy may be as small as possible, ballast tanks have been provided capable of holding enough water to lessen the cruising freeboard 3 ft., so that the target exposed in still water will be represented by a segment of a circle, rising from the water line to 4 ft. above at the center of the vessel.

A novel feature of this armor is the method of supporting it. This is done by a system of longitudinal and transverse girders 18 in. deep. On the inner side of these girders is worked a water-tight skin, serving—in the event of any portion of the deck armor being dislodged—to arrest any inrush of water. The transverse girders will be solid every 12 ft., thus localizing any inflow of water. Great care has been taken to subdivide further the ship into numerous water-tight compartments, all of which connect with both the circulating pumps of the engines and with powerful wrecking pumps, so that any compartment may be readily freed from water.



THE NEW ARMORED COAST-DEFENSE VESSEL.

On the top of the armor deck have been erected tight false-works, increasing the cruising freeboard to 7 ft. 8 in. amidships and giving a comfortable working deck. In order that these false-works may not endanger the stability of the vessel in case they are riddled by machine-gun fire in action, the sides are built double, being 6 in. apart. The space between is filled with cellulose for the entire length of the vessel.

In order that the vessel may be used as a ram the bow is specially formed and strengthened for this purpose. She is also intended for manœuvring rapidly. Her large engine of 7,500 indicated H.P. acts on twin screws, giving a rate of speed of 17 knots. The rudder is moved by steam steering gear. Her radius of action is—for the displacement of the vessel—enormously large, being upward of 8,500 knots at 10 knots speed, her coal supply enabling her to keep the seas as a cruiser above 35 days without recoaling.

A temporary deck-house is a part of the false-works, giving airy accommodations for the officers during peace times. War accommodations have been provided below the armor deck. Great care has been given to the ventilation of all living spaces by means of powerful blowers drawing air from armored ducts, and natural ventilation, through deck lights and armored ventilators.

The ship's principal dimensions are: Length on load line, 235 ft.; beam, extreme, 55 ft.; draft, cruising, 14½ ft.; fighting, 17½ ft.; cruising displacement, 3,030 tons; cruising speed, 17 knots; indicated H.P., 7,500; coal supply, 550 tons; complement of officers and men, 119.

STREET RAILROADS IN EUROPE.

An Austrian engineer, M. de Lindheim, has recently published in Vienna statistics of the street railroads or tramways of Europe, which contain some interesting information. There are in Europe (not including Russia) 221 cities having tramway lines, of which 118 are in Europe; 43 in Germany and 23 in France. The street railroad system has evidently reached a much lower degree of development in Europe than in this country, for it is stated that there is no tramway known to exist in any city having less than 20,000 inhabitants, while in this country they are found in very much smaller cities and even in villages.

The greatest length of tramway reported in any one country is in England, 1,419 kilometers; Germany has only 843, and France, 770. Holland and Belgium are, in proportion to their roads, best supplied with these roads, Holland having 770 kilometers, and Belgium, 612. This is probably due to the dense population of those countries, and the proportionally large number of cities and towns which they contain.

The statistics given by M. de Lindheim are for 1887. The greatest number of passengers reported by the tramways of any one country of that year are 416,518,000 in England; the second being 245,658,000 in Germany. These figures seem small to us, and are very much below those of this country; in New York alone, for instance, in the same year 358,538,000 passengers were carried, including those traveling on the elevated roads, that city alone supplying more street railroad passengers than all of Germany and nearly as many as England. The travel, however, has increased very much in Europe. In the German cities of Berlin, Hamburg, and Stuttgart, in 1870, only 5,000,000 were carried, but in 1887 a single Berlin Company carried 94,000,000, while in Austria the traffic has increased from 12,000,000 to 83,000,000 passengers.

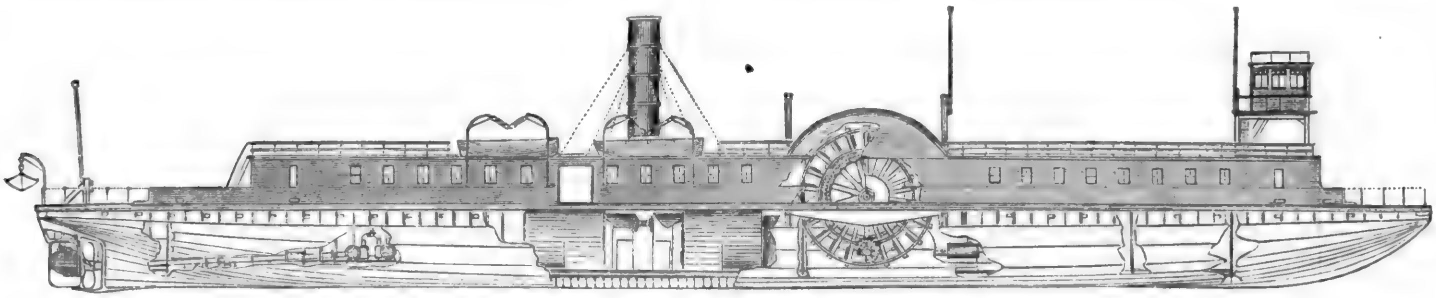
The number of tramway cars reported was 3,494 in England, 3,354 in Germany, 2,780 in France, 1,271 in Austria, 735 in Holland, 715 in Belgium, and 88 in Switzerland. By way of comparison, we may state that there were last year 3,054 cars in service in New York City alone. The cost of these cars varies in a remarkable way, the highest reported being $1,140 in Berlin and $917 in Breslau, while the amount runs down to $564 in Vienna and $556 in Cologne.

It is to be noted that steam motors or locomotives are much more employed abroad than in this country on tram-

ways, no less than 484 being in use on the English lines, 187 in Holland, 111 in Germany, 90 in Austria, 38 in France, and 34 in Belgium, and our authority reports that the use of mechanical motors is making constant progress. He is, himself, an active advocate of the electric motor, holding it to be far superior for tramway use, not only to horses but also to steam motors, and he claims that an electric car can be run for about two-thirds the cost of a horse car.

Some curious statistics are given as to the variation of the tramway traffic at different seasons of the year; thus at Berlin over 9 per cent. of the annual receipts, taking the average of a number of years, was taken in the month of May. July produced at Vienna about 12 per cent. of the annual receipts; at Brussels, 10 per cent. February showed the minimum almost everywhere, its general average being less than 5 per cent. In Vienna nearly 34 per cent. of the annual receipts were taken on Sundays and holidays, the Viennese being notoriously people extremely fond of excursions on such days. At Berlin Sundays and holidays produced 27 per cent. of the receipts, and in Paris about 35 per cent. A curious fact noted is that in all the cities of Europe which report such matters the lightest receipts were on Wednesdays.

It may also be noted that universal experience abroad has shown, according to M. de Lindheim, that a horse of medium weight is capable of much better and longer service on a street railroad than a large and heavy animal.



STEAM FERRY-BOAT FOR THE MICHIGAN CENTRAL RAILROAD.

BUILT BY THE CLEVELAND SHIP-BUILDING COMPANY.

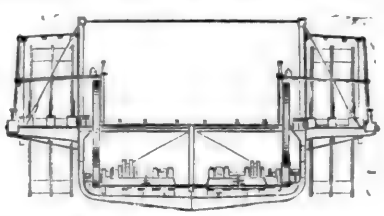
A NEW STEEL FERRY STEAMER.

The Cleveland Ship-Building Company at Cleveland, O., recently completed a large steel ferry steamer to ply between Detroit, Mich., and Windsor, Ont., for the Michigan Central Railroad Company, on the ferry which completes the connection between the main line of that railroad and its Canada Southern Division. This boat, which is shown in the accompanying illustrations, is probably the heaviest steel vessel ever built on the Great Lakes, and both the owners and the builders feel confident that she will be able to transfer cars across the Detroit River in the severest weather, breaking through the heaviest ice that can form there, and keeping up the ferry without the annoying delays heretofore experienced in the winter.

This boat is 280 ft. long over all; 45 ft. 6 in. breadth of hull; 74 ft. 6 in. over the guards, and 17 ft. 3 in. deep. She is built entirely of steel, with the exception of the cabins for the crew; these are located on the guards, leaving a clear deck on which are laid three tracks, each long enough to accommodate seven of the largest cars. When light, but with an ordinary load of coal, etc., on board, the boat draws 9 ft. of water forward and 10 ft. aft; with 21 loaded cars on deck her draft will be about 11 ft. forward and 12 ft. aft. The pilot-house is located on a bridge placed 19 ft. above the main deck and near the bow.

The bow is of the most approved form for breaking through heavy ice, having a vertical section like a sled-runner, the regular scantlings of the ship being increased in weight and reinforced with extra keelsons and bulkheads to give it the necessary strength. The hull is covered with a steel deck; it has a collision bulkhead forward, and bulkheads between the store-room and engine-room; between engine-room and boiler-room; between boiler-room and after engine-room, and at the inboard end of the stern-pipe. The forward and after bulkheads are water-tight, which entirely relieves the vessel from the danger of sinking by contact with heavy ice, and all the bulkheads contribute to the strength of the hull. Between the bulkheads belt-frames are placed on every sixth frame, except for 60 ft. in the wake of the paddle-wheels, where they are placed on every other frame, experience having proved that unusual strength is necessary for boats in this place.

This vessel is propelled by paddle-wheels located forward of the center of its length on each side; these wheels are 27 ft. 6 in. in diameter with wooden arms and buckets all heavily cased in steel, the aggregate weight of each wheel being 66 tons. There is also a 9 ft. 6 in. propeller-wheel in the stern, especially designed for breaking ice. Each side-wheel is driven by a pair of high-pressure engines, geared at right angles to each other, with cylinders 28 in. diameter and 48-in. stroke. The engine shafts are geared to the paddle-wheel shafts by cast-steel pinions 5 ft. 4 in. in diameter, which work in spur gears 16 ft. diameter and 5⅝ in. pitch, placed on the wheel shaft. These spur gears are built of cast-iron centers and arms in two pieces, and 12 cast-steel segments composing the rim; all carefully bolted, fitted, and keyed together. These gears are machine-cut, and as now finished give assurance of great strength and durability. The propeller in the stern is driven by a pair of engines placed at right angles, with cylinders 28 in. diameter and 36-in. stroke, laid horizontally, with separate air-pump and condenser. The screw shaft is 10 in. diameter and 52 ft. long, and is greatly inclined, as the propeller wheel projects 12 in. below the hull proper, being protected by a solid forged skag, which carries the bottom pintle of a solid forged rudder. To protect the rudder when backing into heavy ice there is a



CROSS-SECTION OF STEAMER.

heavy forging framed into the hull, immediately above the rudder, extending down to its top line. This forging is covered by the outside plating of the hull, and when backing into heavy ice the rudder is put amidship, and a heavy bolt inserted through the forging into the rudder frame from the deck, thereby holding the rudder rigidly in a fore-and-aft direction. The after end of this forging extends down over the after corner of the rudder to prevent ice being driven between rudder and horn.

In the forward engine-room is located a beam engine with steam cylinder 16 in. diameter and 36-in. stroke, driving two air-pumps and four bilge-pumps. The center column of this beam engine forms a jet condenser, common to both side-wheel engines.

About the center of the vessel are located four marine,

return-flue boilers of the rectangular fire-box pattern, 11 ft. 6 in. diameter, 16 ft. long, and carrying a working pressure of 90 lbs. The aggregate grate surface is 252 square feet, and the heating surface 9,828 square feet. Along the center line of the ship, between the boilers, are two steam drums connected to a steam separator. The smoke connections are carried to the side of the hull, where they terminate in smoke-stacks, one on each side. Coal bunkers are located amidships, between boilers, extending full length of boiler-room.

Every room and compartment of hull and paddle houses is supplied with coils of pipe for steam heating. On account of the great difficulty of getting water when working in ice, this vessel is provided with 10 sea-cocks, located in different parts of the ship. In the engine-room is a Reynolds patent heater 42 in. diameter and 10 ft. high; also three pairs of duplex steam-pumps for fire purposes, feeding boilers, washing decks, pumping bilges, etc.

The following letter, dated Detroit, January 15, describes the voyage of this steamer from the yard at Cleveland, across the Lake to Detroit:

"The steel ferry steamer *Transfer* arrived here at 2.15 P.M., January 13, and tied up to the Michigan Central Dock, having made the run from Cleveland in 11 hours and 12 minutes, running for an hour and a half of that time under a slow check, and breaking her way through 50 miles of ice from 4 in. to 6 in. thick. Her average speed in open water was 12 miles per hour, and about 10 miles an hour through the ice. She handles perfectly and steams easily with all her engines at maximum speed. Her side-wheel engines were started at 52 revolutions per minute, and her propeller engine at 85 revolutions, making the trip to Detroit without any interruption whatever, excepting only when slowed down by order of the pilot, without heating of journals, alteration or adjustment from port to port. She made a good course from Cleveland to the Dummy.

"The sight of this novel craft, regardless of all precedent, navigating the Detroit River at this season of the year, called the inhabitants of the surrounding country to the river, who welcomed the steamer with waving of flags and handkerchiefs. Immediately upon arrival she was inspected by the boat experts of the city and pronounced a great improvement upon any boat previously built for ferrying on the Detroit River. She was inspected early Monday morning by President Ledyard, General Superintendent Brown, and Assistant General Superintendent Miller of the Michigan Central Railroad, who expressed themselves as perfectly satisfied with the vessel and her appurtenances. On the voyage over the steamer was under command of Commodore Innes of the Michigan Central Ferry Line, assisted by Captain McLaughlin of the passenger steamer *City of Cleveland*. The machinery was in charge of Chief-Engineer Westaway. There were many guests on board, and the builders, the Cleveland Ship Building Company, were represented by H. D. Coffinberry, President; O. N. Steele, Superintendent of Machine Shops; T. W. Bristow, Superintendent of Ship Yards, and J. C. Wallace, Superintending Engineer.

"The weather was fine and nothing occurred during the voyage to mar the pleasure of the trip or give anxiety to those most interested."

Southern Manufactures.

THE *Chattanooga Tradesman*, in its first issue of the year, publishes a large table showing the number of new enterprises actually undertaken in the South during the past year, including factories of all sorts, agricultural implements, cotton and woollen factories, foundries and machine shops, etc. It may be noted that the new enterprises in the iron manufacture continued to increase during the year, 30 blast-furnace companies, 7 rolling-mill companies, and 145 machine-shop companies having been organized, while no less than 217 mining companies were formed, a very large proportion of these being iron-mining companies. There were 12 new car-works started and 3 bridge-works. The general development was indicated by the fact that during the year 253 new railroad companies and 87 street railroad companies were organized, besides 74 electric-light companies in different cities and towns.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 39.)

CHAPTER XXII.

TENDERS.

QUESTION 589. *What are locomotive tenders for?*

Answer. They carry a supply of fuel and water for locomotives while they are running.

QUESTION 590. *How are they constructed?*

Answer. The construction of a locomotive tender is shown and is represented by figs. 356 to 360. Fig. 356 is a side view, fig. 357 a plan, fig. 358 a longitudinal section, fig. 359 an inverted plan, and fig. 360 a front view with the forward truck omitted. It has a rectangular frame, *A A A A*, made of either iron or wood. The frame shown in the engravings is made of iron channel bars, which are rolled bars whose section is similar in form to a letter *E*. Tender frames are, however, often made of wooden timbers. The frame is mounted on a pair of trucks, *B B*, figs. 356 and 358. The top of the frame is covered with planks, *C C C*, which form the floor of the tender. On top of this floor a sheet-iron tank, *D D*, is placed, which carries the supply of water. This tank is made somewhat in the form of a letter ⊃, as shown in the plan. It is made in this way so that the space *B'*, fig. 357, between the two branches *D D*, or "legs," as they are called, will give room for fuel. Around the upper edge of the tank a sheet-iron rim, *E E*, is riveted, so as to prevent the fuel from falling off when it is filled up above the top of the tank.

QUESTION 591. *How are tender tanks filled with water?*

Answer. They are usually filled at water stations with leather or canvas hose connected to a pipe or tank which furnishes a supply of water. The tank has an opening, *F*, on top called a "man-hole" or "filling funnel" into which the hose is inserted, and a stream of water is then allowed to flow through the hose into the tank of the tender. The tank which supplies water to the tender is located higher than the tender, and the water is usually pumped into this tank so that it will run into the tender.

QUESTION 592. *What other way is there of filling tenders with water?*

Answer. To avoid frequent stops for water, express passenger locomotives are sometimes provided with what is called a "water-scoop" for taking water while the engine is running. This consists of a bent tube, *G G G*, figs. 356 to 360, which is attached to the under side of the tank and extends up inside of it to the top. A long trough, *H H H*, figs. 358 and 360, is then laid between the rails and filled with water. The lower end of the bent tube or scoop has a joint or hinge at *I*, so that it can be lowered into the trough, so that the lower end *J* of the scoop will dip a few inches into the water. The motion of the engine then scoops up the water, which is forced up the tube *G G* and discharged into the tank at *K*, fig. 358.

QUESTION 593. *How is the end of the scoop lowered into the water?*

Answer. A shaft, *L*, with two arms, *M* and *N*, is located above the lower end of the scoop. One of these arms, *N*, is connected by a link, *O*, to the movable part of the scoop, and the other arm, *M*, is connected by a rod, *M P* (shown by dotted lines in fig. 358), to a lever, *P Q R*. The fulcrum of this lever is at *Q*, and it has a handle, *R*, at the top. By moving the upper end of the lever backward the scoop is lowered, and by moving it forward the scoop is raised.

QUESTION 594. *How is the water conducted from the tender to the engine?*

Answer. To each side of the front end of the tank one end of a piece of rubber hose *S*, is attached, which is connected at the other end to the pipe on the engine which supplies the pump with water. In some cases this hose is connected directly to the tender tank, but in others small cast-iron cisterns, *T T*, are attached to the bottom of the tank, and the hose is connected to them. The purpose of these cisterns is to prevent air being drawn into the hose when the tank is nearly empty, which would interfere with the working of the pumps or injectors.

QUESTION 595. *How is communication opened and closed between the hose and the tank so as to "turn on" and "shut off" water from the hose?*

Answer. This is done by valves, *U U*, in the bottom of the

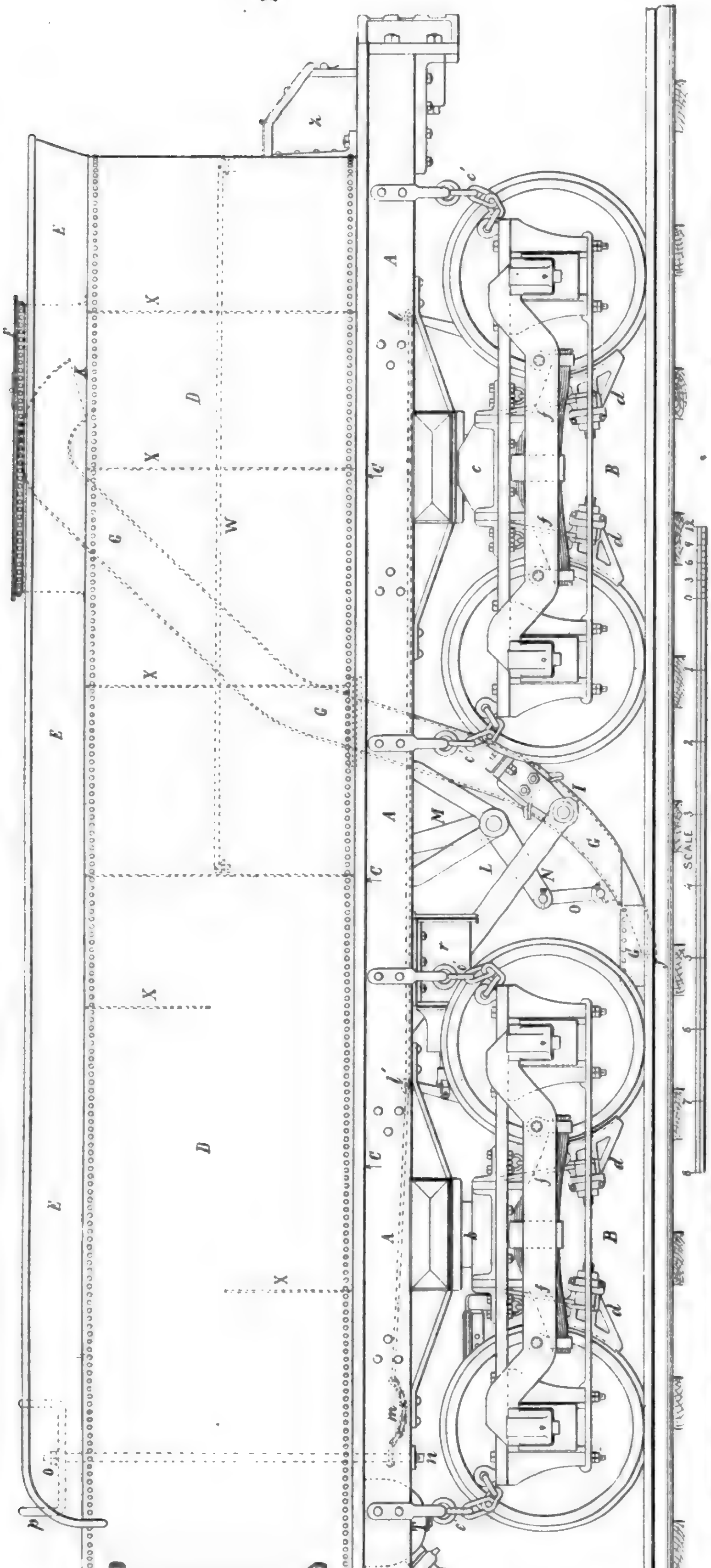


Fig. 356.

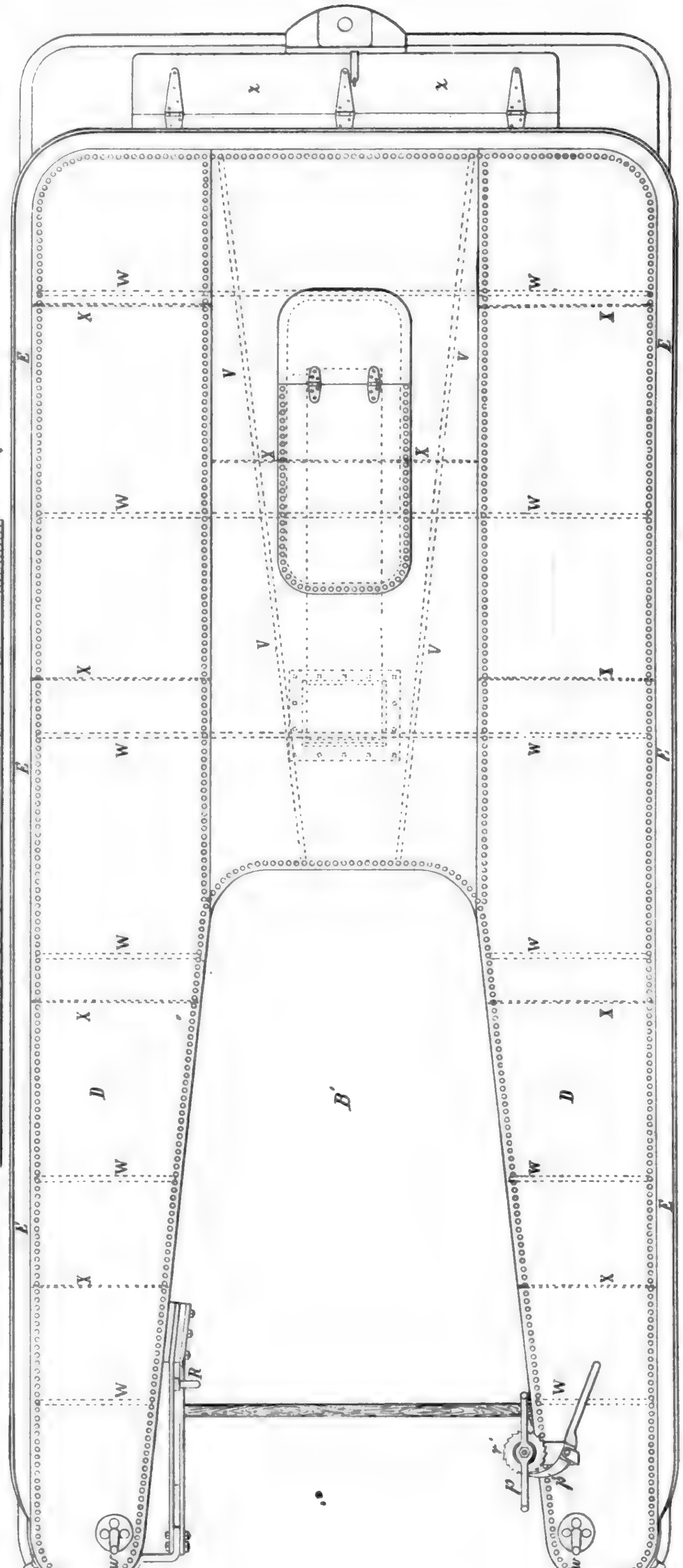


Fig. 357.

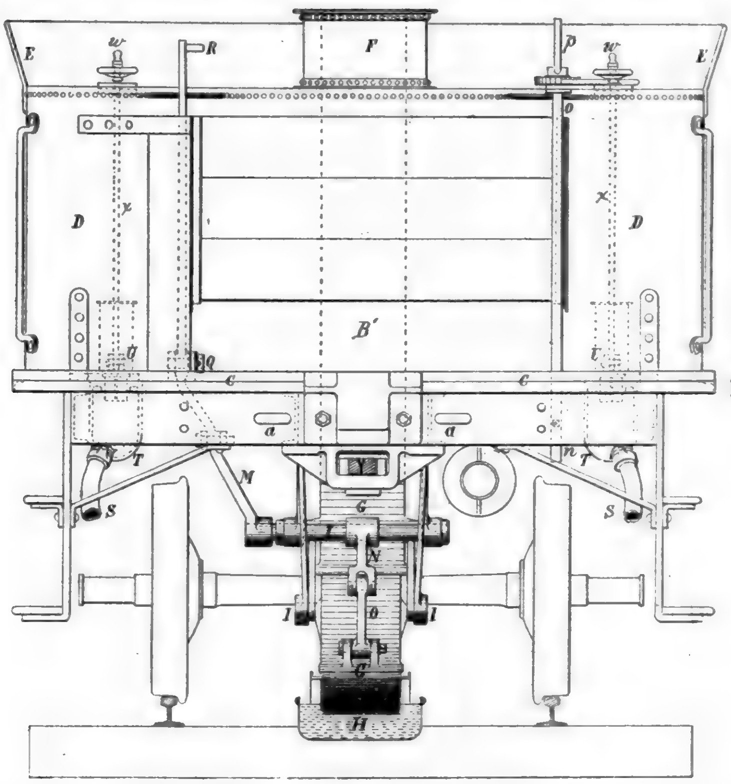


Fig. 360.

tank. A section of one of these valves, with the appliances for opening and closing it, and the cistern, already referred to, is shown on an enlarged scale by figs. 361, 362 and 363. *C* is the cistern and *V* the valve, which is operated by means of a rod, *R R*. This rod has a screw on its upper end, which is screwed into a casting, *A*, that is riveted to the top of the tank. The

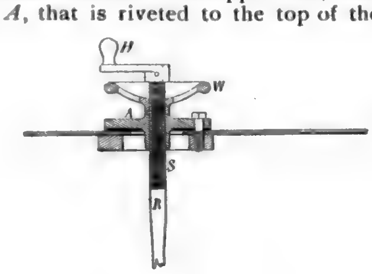


Fig. 361.

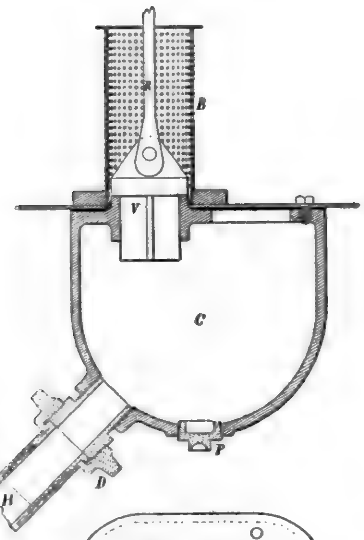


Fig. 362.

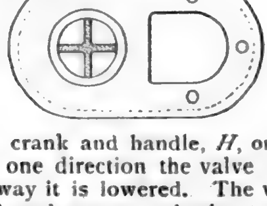


Fig. 363.

screw is turned by a crank and handle, *H*, on its upper end. When it is turned in one direction the valve is raised, and if turned the opposite way it is lowered. The wheel *W* is also screwed on the rod *R*, and acts as a check or lock nut to hold the rod and valve in any desired position. The valve is covered with a hood or strainer, *B*, perforated with small holes, which is intended to prevent dirt from entering the hose and thus getting into and obstructing the pump or injector. The hose is connected to the cistern and to the supply pipe by a screw-coupling, *D*, similar to that used with ordinary fire-engine hose.

QUESTION 596. *How are the flat sides of the tank strengthened so as to resist the pressure and weight of the water?*

Answer. They are sometimes braced or stayed with rods or bars, *V V* and *W W*, figs. 356, 357, and 358, extending from one side to the other and from the top to the bottom, and angle or **T** iron is also riveted to the sides to stiffen them.

QUESTION 597. *How is the violent motion or swash of the water in the tank prevented?*

Answer. Transverse plates, *X X X*, called "swash-plates," are placed in the tank to resist the movement of the water when the tender stops or starts suddenly.

QUESTION 598. *How is the tender connected to the engine?*

Answer. By the draw-bar *Y* and coupling-pin *Z*, fig. 358, and also by the safety chains 50, Plate IV, which are connected to the eyes *a a*, figs. 359 and 360.

QUESTION 599. *In what respect do the tender trucks differ from the engine truck?*

Answer. Chiefly in having the journal-bearings and frames outside of the wheels.

QUESTION 600. *Why are the bearings placed outside instead of between the wheels?*

Answer. Because if they are outside they are then more accessible than if they are between the wheels, and the oil-boxes on the axles can be entirely closed over the ends of the axles, so that no oil can leak out, whereas if the boxes are inside, they must be left open at both ends. When the boxes are on the outside, they can be oiled, or a journal-bearing can be removed and a new one put in its place, with much less difficulty than if the boxes were on the inside of the wheels. The only reason why the bearings of engine-truck-axles are placed inside the wheels is because they would be in the way of the cylinders if they were outside.

QUESTION 601. *How are the axle-boxes for the tender axle constructed?*

Answer. Their construction is similar to that of a car axle-box, the standard form of which is represented in figs. 364, 365, and 366. Fig. 364 is a section lengthwise of the axle, fig. 365 a sectional plan, and fig. 366 a section crosswise of the axle. *A* is the journal of the axle, which is enclosed by a cast-iron box, *K K*, which is open in front and at the back. The front has a cover, *H*, which is either fastened by a spring, as shown in the illustrations, or is bolted to the box. The axle enters the box from the back, *I*, and has either a wood or leather packing, *J J*, called a *dust-guard*, to keep the dust from getting in and the oil from leaking out of the box. *D* is a brass journal-bearing which rests against a cast-iron bearing piece or *key*, *E*, which is put in so that by removing it through the opening *F*, the brass bearing can be raised up high enough to clear the col

Fig. 358.

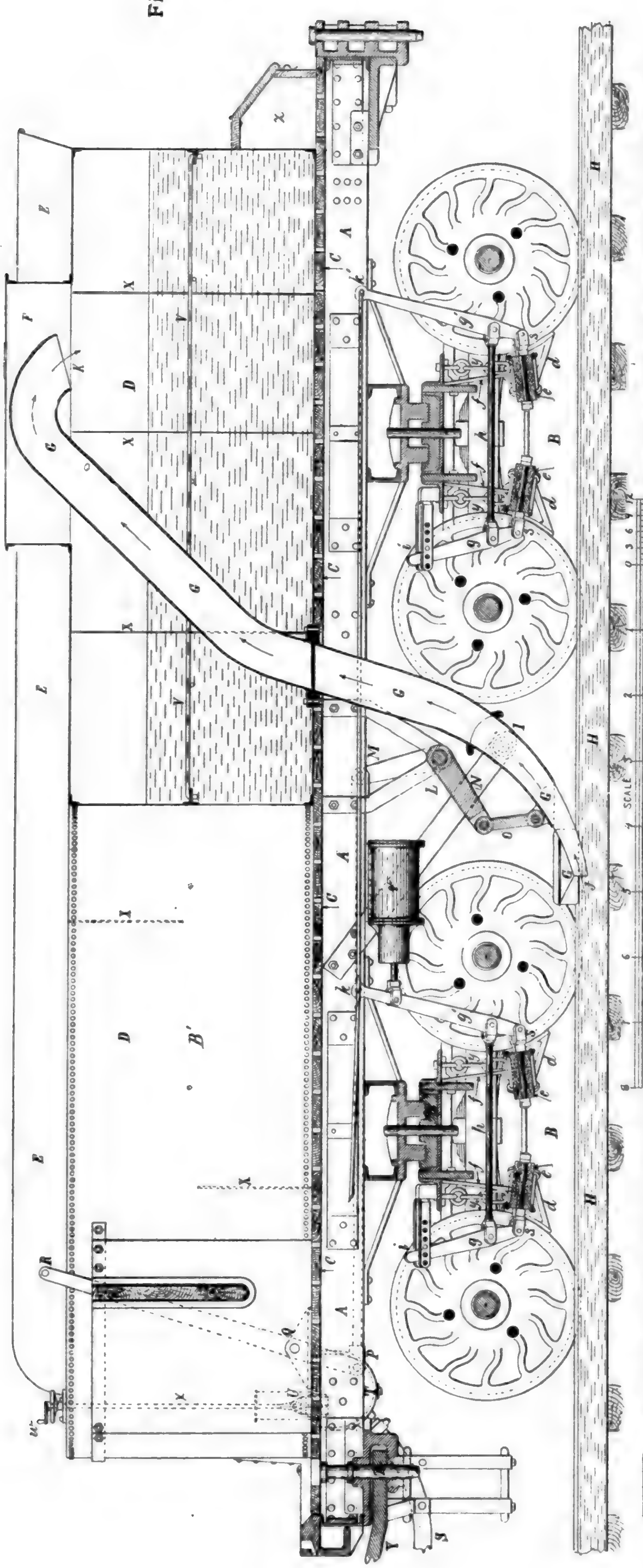
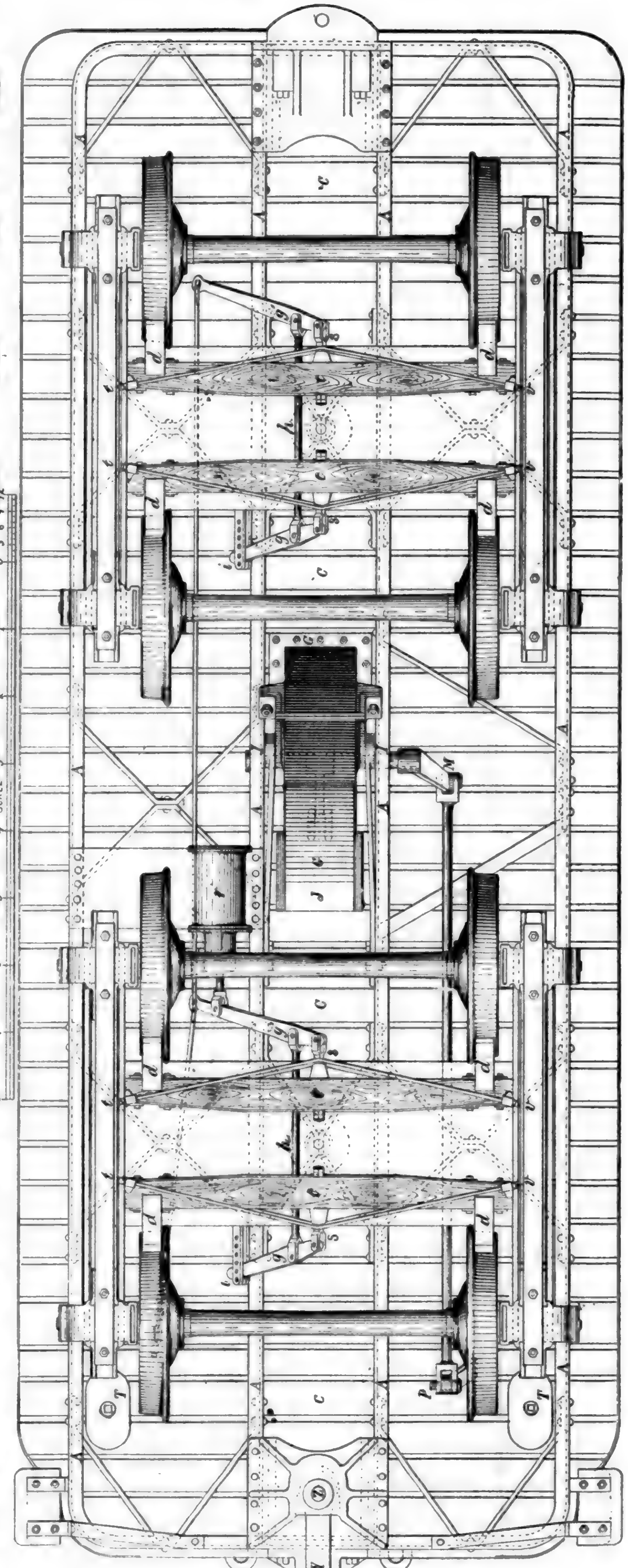


Fig. 359.



lar *G* on the end of the axle and thus be removed in the same way. The lower portion, *L*, of the box under the axle is usually filled with cotton or woolen waste saturated with oil. This constantly presses against the axle, and thus keeps it oiled.

QUESTION 602. *How are the tender trucks constructed?*

Answer. They are made of various patterns, some of which have wooden frames, but they are now usually made of iron. The truck illustrated in figs. 356, 358, and 359 is made of iron, and is very similar to the four-wheeled engine truck which has been illustrated, excepting, as pointed out, that the frames and

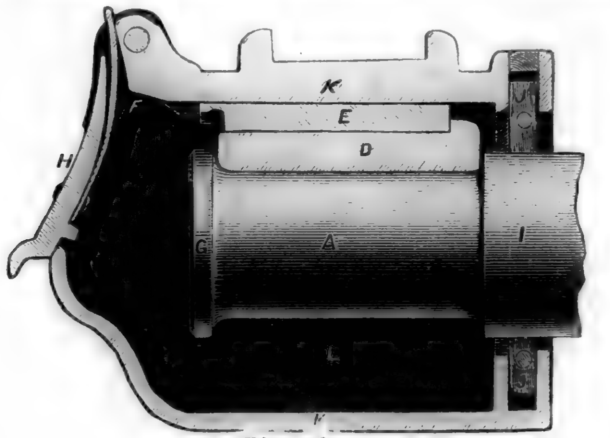


Fig. 364.

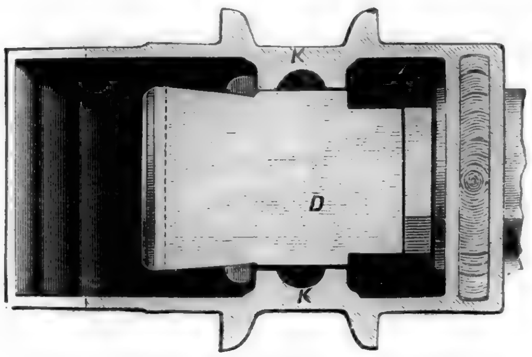


Fig. 365.

journal-bearings are outside the wheels instead of between them.

QUESTION 603. *How are the tenders supported on the trucks?*

Answer. Usually they rest on the center-plate *b*, fig. 358, of the front truck and on bearings *c* on the frames on each side of the back truck. This arrangement gives three bearing points, the advantages of which have already been explained. A truck which supports the load which it carries in the center is said to be *center-bearing*, and if the load is carried on each side, *side-bearing*.

QUESTION 604 *How are the brakes applied to the tender?*

Answer. They are often applied to one truck alone, but both trucks should always have brakes attached to them.

QUESTION 605. *What are the chains c' c' c' c', fig. 356, for?*

Answer. These chains are fastened by one end to the corners of the truck frames and to the tender frame by the other, so as to hold the trucks parallel with the track in case they should get off the rails, as explained in answer to Question 502.

QUESTION 606. *What are the brakes for and how are they constructed?*

Answer. The brakes are for the purpose of stopping the locomotive and tender quickly. They consist of cast-iron blocks, *d d*, figs. 356, 358, and 359, called brake-blocks or brake-shoes, which are attached to transverse wooden or iron beams, *e e*, called *brake-beams*. These beams are suspended from the truck frame by links or hangers, *f f*, called "*brake-hangers.*" Levers *g g g g*, called "*brake-levers,*" are attached to the middle of these beams by pivoted fulcrums. The two levers on each truck are connected together by rods *h* and *h*. The upper end of one of each pair of these levers is held fast by a pin at *i*, and the upper ends *k k* of the other lever are connected together by a rod, *l l'*, fig. 356; *l'* is connected by a rod and chain *m* to a shaft, *n o*. The chain is wound in the shaft, which is turned by a crank, *p*, on the upper end. By this means the upper ends *k k'* of the levers are drawn toward the shaft, which forces the brake blocks against the wheels. A piston in the cylinder *r* is also connected with one of the brake-levers. The piston is operated by compressed air, the action of which will be fully explained in the chapter on air brakes.

CHAPTER XXIII.

THE RESISTANCE OF TRAINS.*

QUESTION 607. *What is meant by the resistance of trains or cars?*

Answer. It is the power required to move them on the track. Thus if a rope, fig. 367, was attached to a car at one end, and

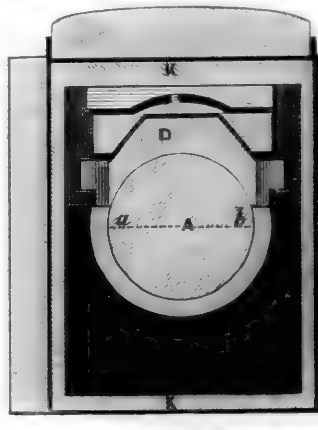


Fig. 366.

the other passed over a pulley, *a*, and a sufficiently heavy weight, *W*, was hung on the end of the rope, it would move the car. The weight *W* would then be equal to the resistance of the car.

QUESTION 608. *How can the resistance of cars under different circumstances be determined?*

Answer. It has been found that it takes a force of about 6 lbs. per ton (of 2,000 lbs.) to move a car slowly on a level and straight track after it is started. That is, if a car weighs 20 tons and a rope, fig. 219, is attached to it at one end and the other passed over a pulley, *a*, with a weight, *W*, suspended to it, it will require a weight equal to $20 \times 6 = 120$ lbs. to keep the car moving slowly. If two cars of the above weight were coupled together, it would require twice 120, or 240 lbs., and if three were attached to each other, three times 120, or 360 lbs., and so on. In other words, MULTIPLYING THE TOTAL WEIGHT OF THE CARS IN TONS (OF 2,000 LBS.) BY 6 WILL GIVE US THEIR RESISTANCE, OR THE FORCE REQUIRED TO KEEP THEM MOVING ON A LEVEL AND STRAIGHT TRACK AT A SLOW SPEED AFTER THEY ARE STARTED. The resistance is represented by the weight above, and the locomotive must exert a force equal to that weight to keep the train moving. As the speed increases the resistance increases, as is shown by the following table. It should be stated here, however, that our knowledge regarding this whole subject of the resistance of American cars and trains is exceedingly inaccurate and imperfect, and the data given in the books are largely based on experiments made in Europe, with cars of a different construction from those used here. There is reason for believing, however, that the resistance of American cars is less than that of European cars, and we have assumed it to be 6 lbs. per ton on a level at very slow speed, which is less than the resistance which is usually given; but the following figures should be regarded merely as an approximation to the actual facts, of which we are still in ignorance:

Velocity of trains in miles per hour..............	5	10	15	20	25	30	35	40	45	50	60	70
Resistance on straight line in lbs. per ton (of 2,000 lbs.)............	6.1	6.6	7.3	8.3	9.6	11.2	13.1	15.3	17.8	20.6	27	34.6

Now, if we want to get the resistance at 30 miles an hour of a train of 10 cars weighing each 20 tons, the calculation would be $10 \times 20 \times 11\frac{1}{4} = 2,250$ lbs. This will give the resistance on a level and straight track. On an ascending grade the resistance is greater than that given above, because, besides pulling the car horizontally, it is necessary to raise it vertically a distance equal to the ascent of the grade. Thus if we have a grade with a rise of forty feet in a mile, the amount of energy required to simply raise the weight of a car would be equal to its weight in pounds multiplied by the vertical height of the

* Since 1873, when the above chapter was written, a considerable number of experiments have been made on the resistance of cars and trains, and much has been written on the subject, but not much additional light has been thrown on it. The original data relating to this subject are therefore retained, although the resistances given are probably too high rather than too low.

ascent. Thus, supposing a car which weighs 40,000 lbs. to be run one mile on a grade of 40 feet ascent in that distance, then the energy expended in simply raising the car will be equal to $40,000 \times 40 = 1,600,000$ foot-pounds. Now, if it was necessary to raise that weight by a direct vertical lift or pull, it would require a force equal to or a little greater than the load to do it. But in pulling a car or train up a grade, which is an inclined plane, the force, which is the locomotive, instead of being exerted through the vertical distance is exerted through the horizontal distance, which in this case is one mile, or 5,280 feet. Therefore, if we divide the number of foot-pounds of energy required by the distance through which the power is exerted, it will give us the force exerted through one foot. That is,

$$\frac{1,600,000}{5,280} = 303.03 \text{ lbs.}$$

The resistance due to the ascent alone of a train on a grade or incline can therefore be calculated by MULTIPLYING THE WEIGHT OF THE TRAIN IN POUNDS BY THE ASCENT IN ANY GIVEN DISTANCE IN FEET AND DIVIDING THE PRODUCT BY THE HORIZONTAL DISTANCE IN FEET. Thus in the above example the rate of the ascent is given in so many feet per mile ; we therefore multiply by 40 and divide by 5,280, which is the number of feet in a

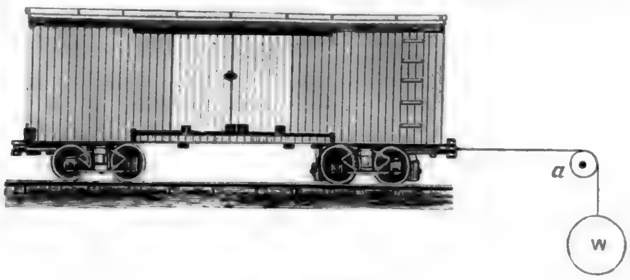


Fig. 367.

mile. If the rate of the gradient had been given, as it sometimes is, as 1 in 132, we would simply have divided the weight of the train by the latter number. If we want to get the resistance per ton of train we substitute for its weight that of one ton in pounds ; thus :

$$\frac{2,000 \times 40}{5,280} = 15.1 \text{ lbs.}$$

If, now, we have the resistance which is due to the *ascent or gravity alone*, we must add to this the resistance on a straight and level track, at the speed at which the train runs, in order to determine the total resistance on the grade. On a level road at a speed of 5 miles per hour it would be 6.1 lbs. per ton, so that on a grade of 40 feet to a mile at that speed the resistance would be $6.1 + 15.1 = 21.2$ lbs., per ton, and at 10 miles it would be $6.6 + 15.1 = 21.7$ lbs., and at 30 miles per hour on the grade the resistance would be $11.2 + 15.1 = 26.3$ lbs. per ton. To get the total resistance on a grade for any speed, we ADD THE RESISTANCE FOR THAT SPEED ON A STRAIGHT AND LEVEL LINE TO THE RESISTANCE DUE TO THE ASCENT ALONE. The resistances for various rates of speed and grades has been calculated, and is given in the table herewith.

The top horizontal row of figures of the table gives the rates of speed. The left-hand vertical row gives the rise of grade in feet per mile. The resistance for any given grade and speed is given where the vertical row of figures under the rate of speed and the horizontal row opposite the rise of the grade intersect each other. Thus, for a grade of 30 feet per mile and a speed of 45 miles per hour, we follow the vertical column under the 45 downward, and the horizontal column opposite 30 to the right, and where the two intersect the resistance, 29.1 lbs., is given.

QUESTION 609. *What effect do curves have on the resistance of trains?*

Answer. They increase the resistance, but in what proportion or to what extent is not known accurately. European authorities say that the resistance is increased, over what it would be in a straight and level line, about 1 per cent. for every degree of the curve occupied by a train. It is probable, however, that the resistance of American cars, which nearly all have double trucks, is not so great on curves as that of European cars, which nearly all have long and rigid wheel-bases, and whose wheels therefore cannot adjust themselves so easily to the curvature of the track as they can when the American system of double trucks is used.

QUESTION 610. *What is meant by a degree of a curve?*

Answer. In order to measure circles, they are all supposed to be divided into 360 equal parts, which are called degrees. One degree of a curve is therefore $\frac{1}{360}$ of a complete circle ; but if the curve has a long radius, one degree of such a curved track will be longer than one degree of a curve with a short radius, but each will have the same amount of "bend" or curvature. It is this latter which increases the resistance of trains, and the greater the number of degrees of a curve occupied by a train of cars, the greater will be the "bend" of the track, and therefore the greater the resistance.

QUESTION 611. *What other causes affect the resistance of trains?*

Answer. The condition of the track and the force and direction of the wind. On a rough track the resistance is very much greater than on a smooth one, and a strong head-wind makes it much more difficult to pull a train than it is in calm weather.

CHAPTER XXIV.

PROPORTIONS OF LOCOMOTIVES.

QUESTION 612. *In proportioning a locomotive to any given kind of work, what are the first facts which should be known?*

Answer. We should first know the weight of the train which the locomotive must draw ; second, the speed at which it must run ; and, third, the steepest grades and the shortest curves of the road on which it must work. From these data the resistance of the train which the locomotive must overcome can be at least approximately determined.

QUESTION 613. *When the greatest resistance of the train is known, what is the next thing to be determined?*

Answer. As was stated in answer to Question 276, if the wheels revolve and their adhesion is greater than the resistance opposed to the movement of the locomotive, the latter will overcome the resistance ; but if the latter is greater than the friction, the wheels will slip. It therefore follows that the adhesion must be somewhat greater than the resistance. As the adhesion is equal to about one-fifth * of the adhesive weight or pressure of the driving-wheels on the rails, obviously this weight should be five times the resistance. Thus, if we have a train weighing 400 tons which we want to take up a grade of 40 feet per mile at a speed of 20 miles per hour, its resistance, calculated from the table given in the previous chapter, would be 9,360 lbs. Therefore, $9,360 \times 5 = 46,800$ lbs. = the required adhesive weight.

QUESTION 614. *What considerations determine the manner of distributing this weight on the wheels?*

Answer. It is found by experience that if too much weight is placed upon one wheel, the material of which the rails are made is partly crushed and injured, and they then wear out much more rapidly than they would if the weight was distributed on more wheels, and thus a smaller amount of weight rested on each point of contact with the rails. The amount of weight which can be carried on a single wheel depends upon the material of which the rails are made, and to some extent on their form and size, or, as the latter is usually expressed, on their weight per yard.

QUESTION 615. *When the adhesive weight and the number of driving-wheels are known, how is the size of the latter determined?*

Answer. The size of the wheels will to a certain extent depend upon the speed, because the larger the wheels, the further will the locomotive move in one revolution ; but no exact rule can be given for their size. At present there is still a great diversity of opinion among engineers regarding the best sizes of wheels for any given service. Probably the safest plan will be to consult the best practice, and in the absence of any better reasons be guided by that.

QUESTION 616. *What requirement determines the size of the cylinders?*

Answer. The cylinders must be large enough so that with the maximum steam pressure in the boiler, they can always turn the driving-wheels when the locomotive is starting, but their size should not be much greater than is needed to turn the wheels, because if they are the pressure on the pistons is liable to cause the wheels to slip on the rails.

QUESTION 617. *How much force must be exerted to turn the driving-wheels?*

Answer. The maximum force which must be exerted to turn the wheels is that required to overcome their friction or adhesion to the rails and make them slip. The adhesion, as explained in Chapter XIV., varies from one-third to one-sixth of the weight bearing on the rails. The cylinders should, therefore, be so proportioned that the greatest tractive force which will be exerted by the pistons will be equal to this adhesion. As it is only under very favorable conditions that the adhesion of the driving-wheels is equal to a third of the weight on them, in calculating the size of cylinders the adhesion should be assumed to be one-fourth the weight on the wheels.

With an ordinary slide valve and link motion working in full

* See answer to question 403.

Table of Resistances of Railroad Trains with Different Grades and Speeds.

Rise of gradient, feet per mile.	Resistance due to ascent alone in lbs. per ton (2,000 lbs.) of train.	Total resistance, lbs. per ton, at rate of 5 miles per hour.	10 miles per hour.	15 miles per hour.	20 miles per hour.	25 miles per hour.	30 miles per hour.	35 miles per hour.	40 miles per hour.	45 miles per hour.	50 miles per hour.	60 miles per hour.	70 miles per hour.
0		6.1	6.6	7.3	8.3	9.6	11.2	13.1	15.3	17.8	20.6	27.0	34.6
5	1.8	7.9	8.4	9.1	10.1	11.4	13.0	14.9	17.1	19.6	22.4	28.8	36.4
10	3.7	9.8	10.3	11.0	12.0	13.4	14.9	16.8	19.0	21.5	24.3	30.7	38.8
15	5.6	11.7	12.2	12.9	13.9	15.2	16.8	18.7	21.9	24.4	27.2	33.6	41.2
20	7.5	13.6	14.1	14.8	15.8	17.1	18.7	20.6	22.8	25.3	28.1	34.5	42.1
25	9.4	15.5	16.0	16.7	17.7	19.0	20.6	22.5	24.7	27.2	31.0	37.4	45.0
30	11.3	17.4	17.9	18.6	19.6	21.9	22.5	24.4	26.6	29.1	31.9	38.3	45.9
35	13.2	19.3	19.8	20.5	21.5	22.8	24.4	26.3	28.5	31.0	33.8	40.2	47.8
40	15.1	21.2	21.7	22.4	23.4	24.7	26.3	28.2	30.4	32.9	35.7	42.1	49.7
45	17.0	23.1	23.6	24.3	25.3	26.6	28.2	30.1	32.3	34.8	37.6	44.0	51.6
50	18.9	25.0	25.5	26.2	27.2	28.5	30.1	32.0	34.2	36.7	39.5	45.9	53.5
60	22.7	28.8	29.3	30.0	31.0	32.3	33.9	35.8	38.0	40.5	43.5	49.9	57.5
70	26.5	32.6	33.1	33.8	34.8	36.1	37.7	39.6	41.8	44.3	47.1	53.5	61.1
80	30.3	36.4	36.9	37.6	38.6	39.9	40.5	42.4	44.6	47.1	49.9	56.3	63.9
90	34.0	41.0	40.6	41.3	42.3	43.6	45.2	47.1	49.3	51.8	54.6	61.0	68.6
100	37.8	43.9	44.4	45.1	46.1	47.4	49.0	51.9	54.1	56.6	59.4	65.8	73.4
110	41.6	47.7	48.2	48.9	49.9	51.2	52.8	54.7	56.9	59.4	62.2	68.6	76.2
120	45.4	51.5	52.0	52.7	53.7	55.0	56.6	58.5	60.7	63.2	66.0	72.4	80.0
130	49.2	55.3	55.8	56.5	57.5	58.8	60.4	62.3	64.5	67.0	69.8	76.2	83.8
140	53.0	59.1	59.6	60.3	61.3	62.6	64.2	66.1	68.3	70.8	73.6	80.0	87.6
150	56.8	62.9	63.4	64.1	65.1	66.4	68.0	69.9	72.1	74.6	77.4	83.8	91.4
160	60.6	66.7	67.2	67.9	68.9	70.2	71.8	73.7	75.9	78.4	81.2	87.6	95.2
170	64.3	70.4	70.9	71.6	72.6	73.9	75.5	77.4	79.6	82.1	84.9	91.3	98.9
180	68.1	74.2	74.7	75.4	76.4	77.7	79.3	81.2	83.4	85.9	88.7	95.1	102.7
190	71.9	78.0	78.5	79.2	80.2	81.5	83.1	85.0	87.2	89.7	92.5	98.9	106.5
200	75.7	81.8	82.3	83.0	84.0	85.3	86.9	88.8	91.0	93.5	96.3	102.7	110.3
210	79.5	85.6	86.1	86.8	87.8	89.1	90.7	92.6	94.8	97.3	100.1	106.5	114.1
220	83.3	89.4	89.9	90.6	91.6	92.9	94.5	96.4	98.6	101.1	103.9	110.3	117.6
230	87.1	93.2	93.7	94.4	95.4	96.7	98.3	100.2	102.4	104.9	107.7	114.1	121.7
240	90.8	96.9	97.4	98.1	99.1	100.4	102.0	103.9	106.1	108.6	111.4	117.8	125.4
250	94.6	100.7	101.2	101.9	102.9	103.2	105.8	107.7	109.9	112.4	115.2	121.6	129.2
260	98.4	104.5	105.0	105.7	106.7	107.0	108.6	110.5	112.7	115.2	118.0	124.4	132.0
270	102.2	108.3	108.8	109.5	110.5	111.8	113.4	115.3	117.5	120.0	122.8	129.2	136.8
280	106.0	112.1	112.6	113.3	114.3	115.6	117.2	119.1	121.3	123.8	126.6	133.0	140.6
290	109.8	115.9	116.4	117.1	118.1	119.4	121.0	122.9	125.1	127.6	130.4	136.8	144.4
300	113.6	119.7	120.2	120.9	121.9	123.2	124.8	126.7	128.9	131.4	134.2	140.6	148.2

gear, the greatest average pressure in the cylinders at a slow speed is about 90 per cent. of the boiler pressure. From this the greatest mean tractive force may be calculated by the rule given in answer to Question 405.* As the stroke of the pistons is usually known, the problem generally is to determine the diameter of the cylinders, which, with an average pressure of 90 per cent. of the maximum boiler pressure, will give a tractive force equal to the adhesion of the wheels, assuming that to be equal to the weight on them. Having the adhesion and knowing the boiler pressure, the tractive force for different-sized cylinders can be calculated until the diameter is found which will be of the right size. But as this will be tedious, the following rule, which will give the right diameter with one calculation, will be found convenient:

TO GET THE AREA OF THE PISTONS OF A LOCOMOTIVE.

MULTIPLY ONE-FOURTH OF THE WHOLE WEIGHT (IN POUNDS) WHICH RESTS ON THE RAILS UNDER THE DRIVING-WHEELS BY THE CIRCUMFERENCE (IN INCHES) OF THESE WHEELS. THEN MULTIPLY 90 PER CENT. OF THE MAXIMUM BOILER PRESSURE (IN LBS. PER SQUARE INCH) BY FOUR TIMES THE STROKE OF THE PISTON (IN INCHES), AND DIVIDE THE FIRST PRODUCT BY THE SECOND. THE QUOTIENT WILL BE THE AREA OF EACH PISTON IN SQUARE INCHES.*

To apply this rule to an actual example, an engine with pistons 18 in. diameter and 24-in. stroke, and with driving-wheels $5\frac{1}{2}$ ft. = 66 in. in diameter, loaded with 64,000 lbs. = 32 tons and a maximum boiler pressure of 150 lbs. per square inch, will be taken. The circumference of these wheels will be 207.3 in., so that by the rule we will have:

* NOTE.—A committee of the Master Mechanics' Association appointed to report on this subject have recommended that the pressure in the cylinders be taken at 85 per cent. of the boiler pressure; but in order to have the cylinders as nearly of the right size as possible during all conditions of the tires, they based their calculations on the diameter of the tires when half worn out. As this introduces an element of confusion in comparing the dimensions of different engines, it has been preferred to base the calculations on a somewhat higher percentage of boiler pressure and on the original diameter of the tires, which gives nearly the same results and avoids the confusion referred to.

* NOTE.—This rule has been worked out algebraically as follows:

Let A = Area of one piston (in square inches).
P = Maximum boiler pressure (per square inch).
p = Mean pressure (per square inch) in the cylinder.
S = Stroke of piston (in inches).
C = Circumference of driving-wheels (in inches).
W = Total weight on rails below all the driving-wheels (in pounds).

As p is assumed to be $= .90\,P$ the tractive force, by the rule given in answer to Question 405, will be $= \frac{A \times .90\,P \times 4\,S}{C}$.

The adhesion has been assumed to be equal to $\frac{1}{4}\,W$, and as the tractive force and the adhesion should be equal, we have

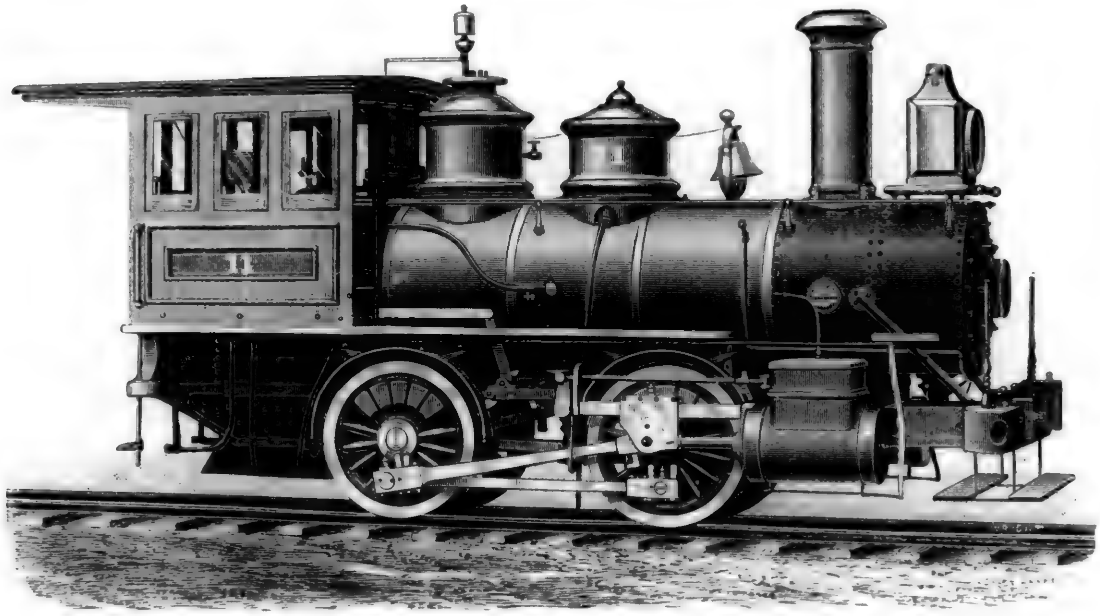
$$\frac{A \times .90\,P \times 4\,S}{C} = \tfrac{1}{4}\,W,$$

from which we have

$$A = \frac{\tfrac{1}{4}\,W \times C}{.90\,P \times 4\,S}.$$

It is not easy to give the demonstration of this rule without the use of algebra, and those not acquainted with that branch of mathematics must accept the rule on faith.

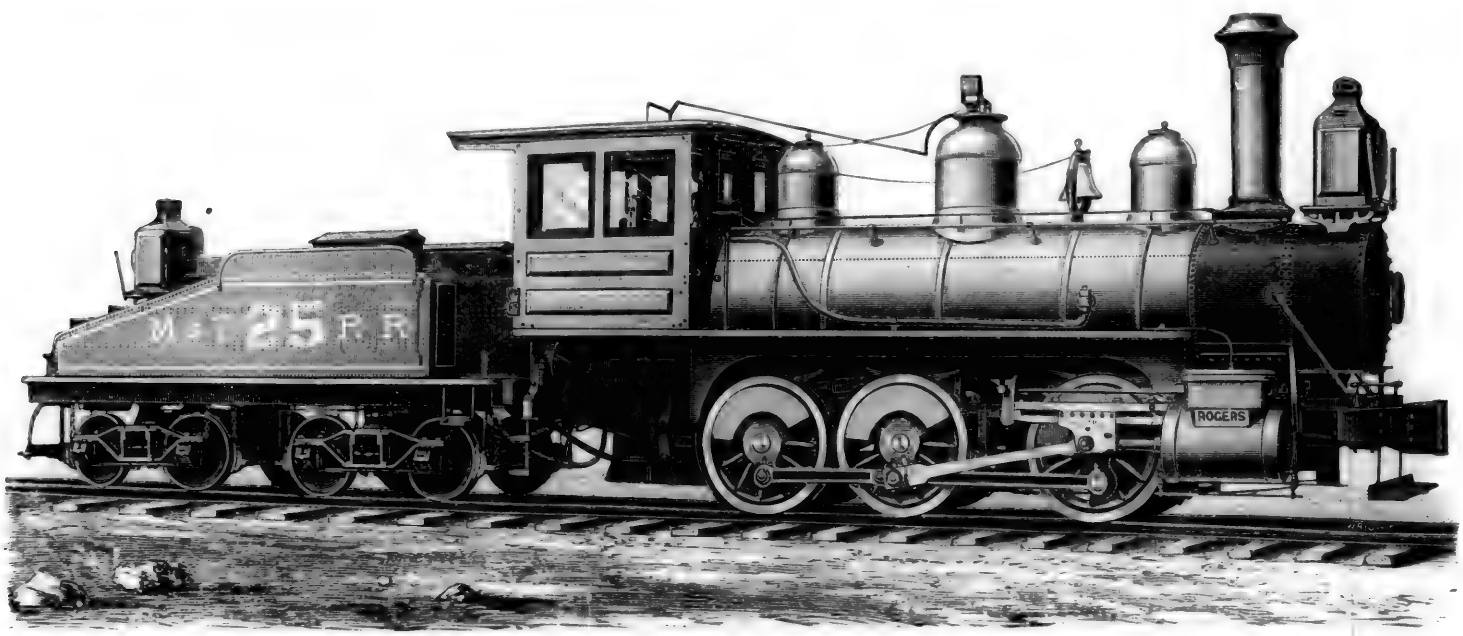
CATECHISM OF THE LOCOMOTIVE.



FOUR-WHEELED SWITCHING LOCOMOTIVE.

BY THE COOKE LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	59,000 lbs.	Length of fire-box, inside	4 ft. 0 in.	Exhaust nozzles	Single.
Total weight on driving wheels	59,000 "	Width of fire-box, inside	2 " 10 "	Size of steam-ports	15½×1¼ in.
Diameter of driving wheels	4 ft. 0 in.	Depth of fire-box, crown-sheet to top of grate	4 " 3 "	Size of exhaust-ports	15½×2¼ "
Diameter of main driving-axle journal	7 "	Number of tubes	150	Throw of eccentrics	5½ "
Distance from center of front to center of back driving-wheel	6 ft. 10½ "	Outside diameter of tubes	2 in.	Greatest travel of valve	5 "
Total wheel-base of engine	6 " 10½ "	Length of tubes	10 ft. 5¾ "	Outside lap of valve	0¾ "
Total wheel-base of engine and tender	31 " 5½ "	Grate surface	11½ sq. ft.	Smallest inside diameter of chimney	1 ft. 4 "
Diameter of cylinders	16 "	Heating surface, fire-box	73 " "	Height, top of rail to top of chimney	12 " 9 "
Stroke of cylinders	24 "	Heating surface, tubes	711 " "	Height, top of rail to center of boiler	5 " 8½ "
Outside diameter of smallest boiler ring	48 "	Heating surface, total	784 " "	Water capacity of tank	2,000 gals.



SIX-WHEELED SWITCHING LOCOMOTIVE.

BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	85,000 lbs.	Length of fire-box, inside	4 ft. 6 in.	Exhaust nozzles	Double.
Total weight on driving wheels	85,000 "	Width of fire-box, inside	2 " 9¾ "	Size of steam-ports	14½×1¼ in.
Diameter of driving wheels	4 ft. 2 in.	Depth of fire-box, crown-sheet to top of grate	5 " 0 "	Size of exhaust-ports	14½×2½ "
Diameter of main driving-axle journal	7 "	Number of tubes	123	Throw of eccentrics	5 "
Distance from center of front to center of back driving-wheel	10 ft. 6 "	Outside diameter of tubes	2¼ in.	Greatest travel of valve	5 "
Total wheel-base of engine	10 " 6 "	Length of tubes	13 ft. 10½ "	Outside lap of valve	0$\frac{11}{16}$ "
Total wheel-base of engine and tender	37 " 1 "	Grate surface	12⅔ sq. ft.	Smallest inside diameter of chimney	1 ft. 3 "
Diameter of cylinders	17 "	Heating surface, fire-box	83 " "	Height, top of rail to top of chimney	14 " 6 "
Stroke of cylinders	24 "	Heating surface, tubes	1,005 " "	Height, top of rail to center of boiler	6 " 3¾ "
Outside diameter of smallest boiler ring	51 "	Heating surface, total	1,088 " "	Diameter of tender-truck wheels	2 " 9 "
				Water capacity of tank	2,000 gals.

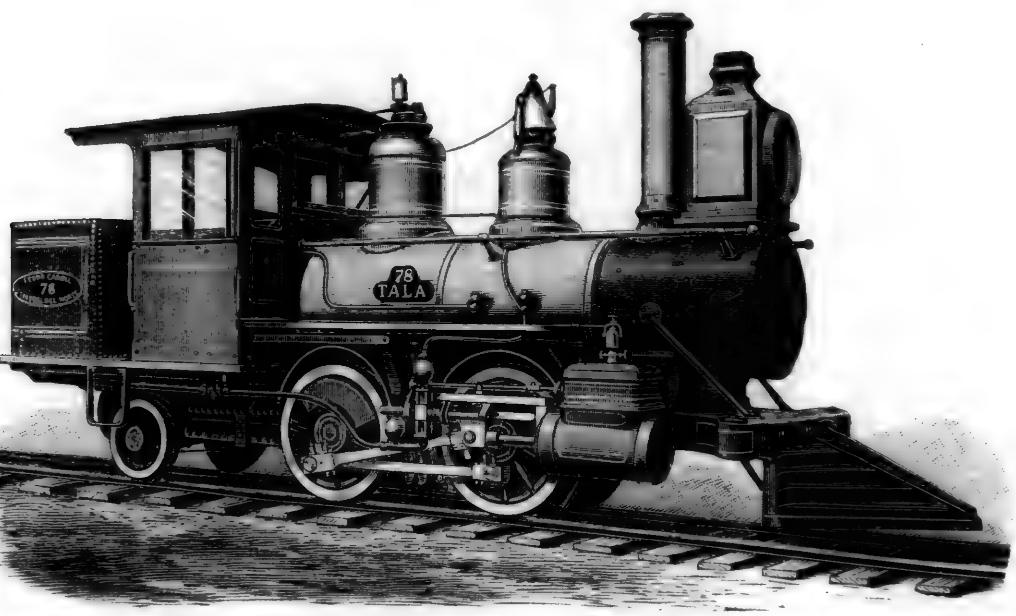
CATECHISM OF THE LOCOMOTIVE.

GRANT PONY LOCOMOTIVE.

BY THE GRANT LOCOMOTIVE WORKS, PATERSON, N. J.

Diameter of driving wheels	4 ft. 2 in.	Diameter of cylinders	14 in.	Number of tubes	126
Diameter of truck wheels	2 " 4 "	Stroke of cylinders	22 "	Outside diameter of tubes	2 in.
Number of driving wheels	4	Length of fire-box, inside	6 ft. $1\frac{1}{8}$ "	Length of tubes	7 ft. $10\frac{5}{16}$ "
Number of truck wheels	2	Width of fire-box, inside	2 " $9\frac{7}{8}$ "	Water capacity of tank	1,498 gals.

NOTE.—The original drawings of this engine were destroyed by the fire at the works in September, 1887, so that full specifications could not be obtained.



FORNEY PONY LOCOMOTIVE.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

Total weight in working order	36,840 lbs.	Length of fire-box, inside	2 ft. 4 in.	Exhaust nozzles	Double.
Total weight on driving wheels	28,500 "	Width of fire-box, inside	3 " $3\frac{1}{2}$ "	Size of steam-ports	9 × 1 in.
Diameter of driving wheels	3 ft. 1 in.	Depth of fire-box, crown-sheet to top of grate	2 " 10 "	Size of exhaust-ports	9 × $1\frac{3}{4}$ "
Diameter of truck wheels	2 " 0 "	Number of tubes	97	Throw of eccentric	$3\frac{1}{2}$ "
Diameter of main driving-axle journal.	$4\frac{1}{2}$ "	Outside diameter of tubes	$1\frac{1}{2}$ in.	Greatest travel of valve	$4\frac{3}{8}$ "
Distance from center of front to center of back driving wheels	4 " 6 "	Length of tubes	8 ft. $0\frac{1}{4}$ "	Outside lap of valve	$0\frac{11}{16}$ "
Total wheel-base of engine	10 " 9 "	Grate surface	7 sq. ft.	Smallest inside diameter of chimney	10 "
Diameter of cylinders	10 "	Heating surface, fire-box	33 " "	Height, top of rail to top of chimney	11 ft. 6 "
Stroke of cylinders	16 "	Heating surface, tubes	300 " "	Height, top of rail to center of boiler	4 " 6 "
Outside diameter of smallest boiler ring	34 "	Heating surface, total	333 " "	Water capacity of tank	450 gals.

$$\frac{64.000}{4} = 16,000 \times 207.3 = 3,316,800,$$

and $150 \times .90 \times 4 \times 24 = 12,960,$

and $\frac{3,316,800}{12,960} = 255.9 =$ area of cylinder.

Having the area the diameter can readily be ascertained by calculation, or from a table of diameters and areas. In this case the diameter is 18 in. very nearly.

QUESTION 618. *What are the three elements which determine the size of the cylinders?*

Answer. From what has been said it will be seen that the size of the cylinders is governed by, first, the weight on the driving-wheels; second, the diameter of those wheels; and, third, the steam pressure.

QUESTION 619. *Are the sizes of cylinders generally determined by these considerations?*

Answer. No; many locomotive superintendents regard the expansive action of the steam in the cylinders as of more importance in determining their size than any other consideration, and therefore they make the cylinders larger than the above rule would indicate they should be. In other cases cylinders are made of considerably smaller sizes than would be given by the rule. Caprice and prejudice seem to have had considerable influence in determining the proportions of cylinders.

QUESTION 620. *In what way can we compare the relative sizes of cylinders, taking into account the weight on the driving-wheels, their size, and the steam pressure?*

Answer. The method of doing this can be best explained by taking, as an example, a standard passenger locomotive with cylinders 18-in. diameter and 24-in. stroke, driving-wheels $5\frac{1}{2}$ ft. = 66 in. diameter, and with 64,000 lbs. of load on these wheels. The circumference of such wheels is 207.3 in., and if they do not slip the locomotive will move that distance on the rails while they revolve once. At the same time each piston will sweep through its cylinder twice, and therefore during one revolution of the wheels four times one cylinder full of steam is used. The cubical space that a piston 18 in. diameter and 24-in. stroke sweeps through in moving from one end of the cylinder to the other is equal to 6,107 cubic inches, so that in one revolution of the wheels $6,107 \times 4 = 24,428$ cubic inches of steam are used. If, then, we divide 24,428 by 207.3 in., the distance that the locomotive moves during one revolution of its driving-wheels, it will give us the amount of steam used to move the locomotive and train one inch. That is, $24,428 \div 207.3 = 117.8$. It will thus be seen that a locomotive of the dimensions given, and with 64,000 lbs. or 32 tons (of 2,000 lbs.) of adhesive weight, has 117.8 cubic inches of cylinder capacity * to move it one inch. If the locomotive had only half as much weight on the driving-wheels, it could pull only half as much load, and would therefore use only half as much steam, and consequently need only half the cylinder capacity of the other locomotive. If there was three-quarters or a third as much adhesive weight, the cylinder capacity should also be three-quarters or a third. In other words, the cylinder capacity should be proportioned to the adhesive weight. If, then, we divide the number of cubic inches of steam consumed while the engine moves one inch by the number of tons of adhesive weight, it will give us the number of cubic inches of cylinder capacity per ton of adhesive weight. Applying this to the preceding example, $117.8 \div 32 = 3.68$ cubic inches will be the cylinder capacity per ton of adhesive weight and per inch of the circumference of its driving-wheels. This quantity has been named the *modulus of propulsion*, which can be calculated by the following rule:

MULTIPLY THE AREA OF ONE PISTON (IN SQUARE INCHES) BY THE STROKE (IN INCHES) AND THE PRODUCT BY FOUR. DIVIDE THIS PRODUCT BY THE CIRCUMFERENCE OF THE DRIVING-WHEELS (IN INCHES) AND BY THE WEIGHT (IN TONS OF 2,000 LBS.) ON ALL THE DRIVING-WHEELS. THE QUOTIENT WILL BE THE MODULUS OF PROPULSION.

This varies considerably in different locomotives. Thus in some consolidation engines built for the Denver & Rio Grande Railroad, the cylinders were 20 in. diameter and 24-in. stroke, the wheels 46 in. diameter with 103,000 lbs. of weight on them. The modulus of propulsion on these engines is 4.05, instead of 3.68, as in the other case.

To get a measure of the cylinder capacity which will also take the steam pressure into account, we should divide the modulus of propulsion by the maximum boiler pressure per square inch. This quantity has been named the *modulus of traction*. Thus in the first example the boiler pressure was assumed to be 150 lbs., and therefore $3.68 \div 150 = .02453$, in the second it was 140 lbs., so that $4.05 \div 140 = .02893$. Experience seems to indicate that a modulus of traction of about .025 will give very good results in practice.

It should be remarked here that it is unimportant, so far as the power of the locomotive is concerned, whether the cylinders have a large diameter and a short stroke or a small diameter and a long stroke, provided the cubical contents are the same. Thus, cylinders $17\frac{1}{2}$ in. in diameter and with 20-in. stroke would have almost exactly the same capacity, and the same power would be exerted with them as with cylinders 16×24 in.; the only difference would be that with the cylinder of the largest diameter the pressure on the piston, and consequently on the crank-pin journal, and the strain on the parts would be greater than with the smaller cylinder. The difference in pressure would, however, be exactly compensated by the loss or gain in the leverage exerted through the driving-wheels on the rails.

QUESTION 621. *What circumstances should determine the size of locomotive boilers?*

Answer. They should be proportioned to the amount of adhesive weight, and to the speed at which the locomotive is intended to work. Thus, a locomotive with a great deal of weight on the driving-wheels could pull a heavier load, and would, by the above rule for proportioning the cylinders, have a greater cylinder capacity than one with little adhesive weight, and would therefore consume more steam, and therefore should have a larger boiler. It is also obvious that if a locomotive like that shown in Plates I and II should have a boiler just large enough to furnish steam when running at the rate of 20 miles an hour, it would be too small if the locomotive ran 40 miles an hour, the train resistance being the same in both cases. Driving-wheels 5 feet in diameter would at 20 miles per hour make 112 revolutions per minute, and would therefore consume 448 cylinders full of steam. At 40 miles per hour double the number of revolutions would be made, and consequently twice the quantity of steam would be used, and therefore the boiler should have twice the steam-producing capacity. If, therefore, we know the size of a boiler required for a given amount of adhesive weight and a given speed, we can easily calculate the boiler capacity for any other weight and speed.

QUESTION 622. *What circumstances usually determine the size and proportion of locomotive boilers?*

Answer. The weight and dimensions of locomotive boilers are in nearly all cases determined by the limits of weight and space to which they are necessarily confined. It may be stated generally that *within these limits a locomotive boiler cannot be made too large.* In other words, boilers for locomotives should always be made as large as is possible under the conditions that determine the weight and dimensions of the locomotives.

(TO BE CONTINUED.)

* The cylinder capacity is the space swept through by the two pistons. In the above illustrations what is meant is, that the average space in the cylinder swept through by the piston is 117.8 cubic inches for each inch that the locomotive advances.

Manufactures.

A New Universal Milling Machine.

THE accompanying illustration shows a new universal milling machine. It is designed for boring, drilling, facing, milling, profiling, key-seating, cotter-drilling, rack-cutting (any length), gear-cutting, etc.

The gearing is made either internal or external as desired, the internal being 4 to 1 and external 8 to 1; it is driven by a 3-in. belt on a 4-step cone, the largest diameter of which is 11 in. All running parts have oil tubes and are accessible for oiling.

The spindle is of extra quality hammered cast steel, and runs in bronze boxes. The front bearing is 3 in. in diameter and $4\frac{1}{2}$ in. long; back bearing 2 in. diameter and 4 in. long, and provided with easy means of adjustment for wear. The front end of the spindle is threaded on the outside for face-plates or face-mills. In the spindle is a taper hole for cutter arbors $1\frac{1}{2}$ in. diameter at the front end, diminishing $\frac{1}{2}$ in. in 12 in, to $1\frac{1}{16}$ in. diameter, through which the arbors are driven out by a rammer. The bronze boxes have an adjustment by which the original centers are always retained without altering their position laterally—this is a very important point, as the journal and bearing wear always in the same place. In all other sleeve bearings, when wear is taken up by moving either the box or spindle laterally, a new position is taken and wear commences and takes place very fast. This style of bearing overcomes this entirely.

The cutter-arbor supporting bar, with its adjustable center, can be moved out to support cutter-arbors from the end of the spindle or pushed back out of the way, thus facilitating the milling or boring of a large piece of work that would be prevented by the ordinary fixed bar. It is $3\frac{1}{4}$ in. diameter, and of solid cast steel, making a very rigid support. A harness is furnished for the bar, to fasten to the knee of machine when large cutters

are used on extra heavy work; this is a feature that adds to its value, as can be readily seen.

The three feeds, vertical, horizontal (in line with spindle), and transverse (at right angles to spindle), are all *reversible*, and are operated or stopped altogether by the handle shown in the cut near the cupboard board. This reversing device is common to engine lathes, does away with the crossing of belts and saves time. The 3-step cone on the spindle belts to the lower cone, the shaft of which runs in a hollow stud and drives, by means of the reversing device referred to above, a shaft running through the base of the column. Bevel gears connect this shaft with the vertical shaft, and the latter by bevel gears with the horizontal shaft in the knee, which communicates in turn with the several screws for the various feeds in the front of the knee by clutch gears. These clutch gears can be engaged or disengaged at will by the knurled knobs shown in front, giving a vertical or horizontal feed. The platen feed is operated from the upper shaft in the knee by means of a pair of miter wheels running in a bearing which is a part of the platen slide on the knee. A vertical stud passes upward to the long screw in the platen, and is connected to it by clutch miter wheels. The screw in the platen is splined, and can be engaged and disengaged by a clutch lever, shown in the cut, convenient to the operator.

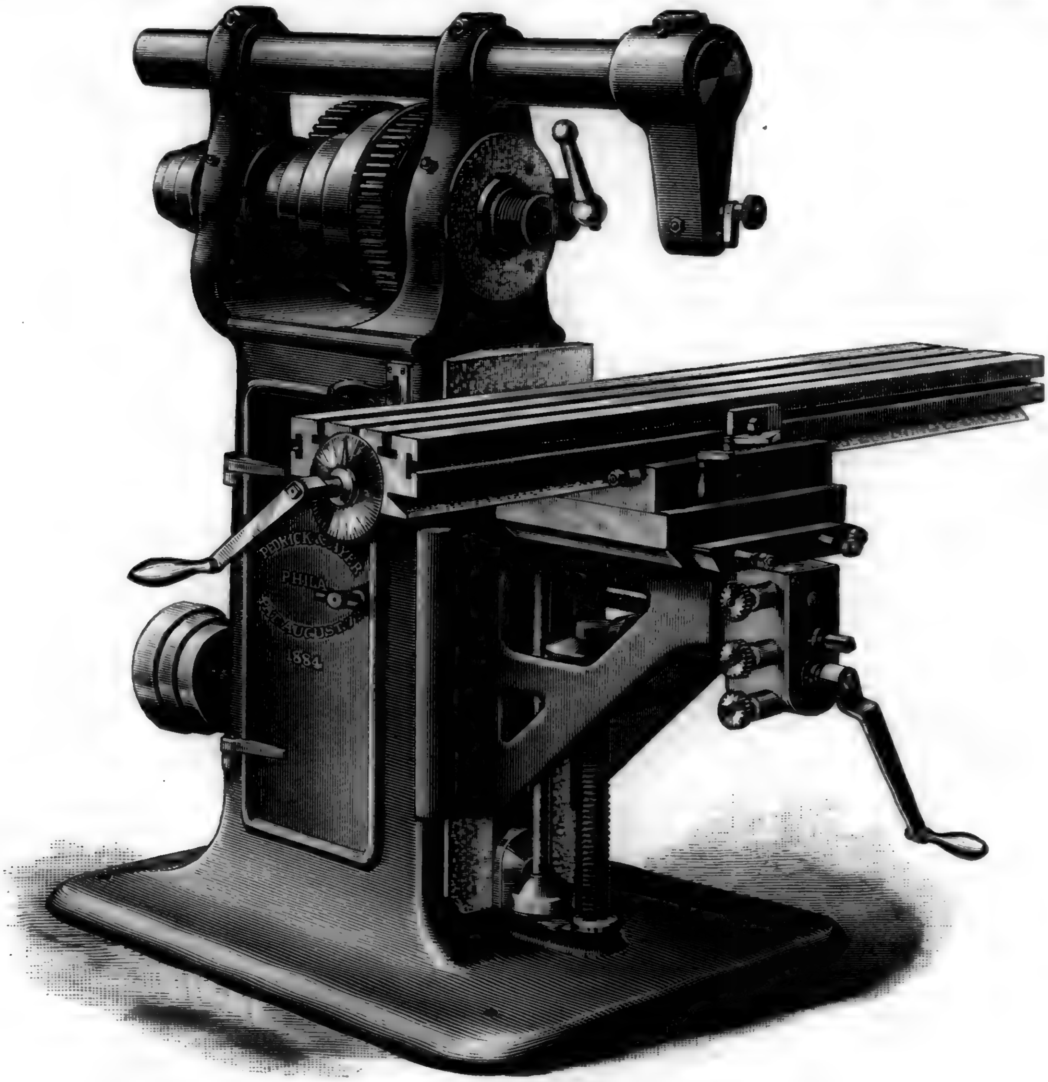
The platen is 48 in. long, 9¼ in. wide, and has two slots for ⅝-in. bolts on the top and on the edges two slots. The latter are very useful and convenient. The platen has a transverse feed of 33½ in. and a horizontal feed of 7⅜ in. It can be turned completely around and fed in line with the spindle. It has an automatic stop, while feeding in either direction, and is secured by four ⅝-in. steel bolts in the swivel base, of easy access with a wrench.

The knee is so designed and constructed as to withstand all strains liable to be brought upon it. It has a bearing 17 in. long and 10½ in. wide.

The feed gearing is well protected from dirt, and the mechanism is not liable to disarrangement. All gears and screws are of steel, and are accurately cut. The dials read in decimals, or divided by 2, 4, 8, etc., enabling any measurement to be made.

The base of this machine is 30 by 40 in., and the spindle is 42 in. from the floor. The total weight of the machine is 2,600 lbs.

This is a very useful tool in the shop, owing to its wide range of work. It is manufactured by Pedrick & Ayer, at No. 1025 Hamilton Street, Philadelphia.



NEW UNIVERSAL MILLING MACHINE.

A Fortune for Seat-Makers.

(From the New York *Sun*.)

THOUSANDS of models of a perfectly comfortable seat will be made this winter in the Northern States by healthy boys playing in snow-banks. They will cast themselves backward against the slope of the drifts, and sink and wriggle themselves into a position of heavenly rest, in which the absolute content of the head, shoulders, back, and legs allures body and soul to slumber, even in a temperature of zero. And there is not a chairmaker in this smartest of nations smart enough thus far to have made a chair on the lines left in the snow-bank by the boy's body.

For forty-five years the male American's experience of chairs and other furniture to sit on has been a martyrdom to ignorance and fashion. Their convex surfaces may be the deserved punishment of our national sin of permitting unrestricted immigration. They came from Germany, and were the treacherous gift of German upholsterers to the confiding republic that welcomed and fostered them. By reason of the convexity of the seats, there is not in any well-furnished parlor in this city a comfort-

able chair or sofa. To sit on them is to sit on a globe or a cannon-ball. The seat should always be hollow.

We recall at this instant the administrator's sale in Albany of the furniture of the great John C. Spencer, ex-Secretary of the Navy, and of nearly every other department in Washington, and we remember the admiration by the most intelligent crowd in the great State Street mansion of the "dishing" of the hair-cloth seats of all the chairs, sofas, and lounges in the several rooms. They had been wisely fashioned, it was said by Mr. Spencer himself, on an approach to the hollowness of the seat of the shoemaker's bench, the most comfortable seat man has ever sat on.

But the palm for reckless cruelty and unthinking stupidity in the manufacture of furniture for domestic life is easily carried off by our American swift money-makers. Consider the rocking-chair which curses our places of summer resort, seaside, and mountain. Look at the abominable thing laterally! It is the contrivance of an idiot or a devil. The seat slopes steeply backward. The rockers, short and excessively curved, serve additionally to throw the front edge of the seat up into the air. This lifts the sitter's feet from the floor, and brings the weight of the legs on the sharp edge of the seat front, and accomplishes a torture which no human being can endure for over fifteen minutes without an outcry or an oath. Regard the thing's back! A recess, too deep by half, invites the shoulders to repose. Below this recess a malicious bulge in the structure jams the tender small of the back, forces the lower part of the spine to sustain the entire weight of the reclining trunk, and defeats possibility of rest to the shoulders. It must have been a Puritan cabinetmaker's idea of the line of beauty that established the curvature of the American rocking-chair's back, which from the shoulders up recedes into space and mockingly refuses the weary head.

Certainly, there is a great fortune for somebody in a perfectly restful seat on chair, sofa, and rocker for American use. The nation is in a state of mad revolt, and in a mood to be reckless about the price of relief. The mechanic who starts for this gold mine must carry in his hand and hold before his eyes the "convex" utterly smashed, hated, despised, and spit on. The established model of our rocking-chair's back must be felt by him to be the unpardonable sin and the crowning shame of American household art. This mechanic's soul must be filled with a reverence for curled horse-hair, and his gorge must rise chronically against moss, excelsior, tow, shoddy, and rags as material for a seat for an honest man to make for a good man to sit on.

Thus equipped, he should go reverently to a country snow-bank, and fill his soul and memory with the lines of the heavenly rests made by the red-cheeked, wholesome boys in the yielding slopes of the flaky walls, and carefully take their measurements and angles for the fixed principles and unchangeable rules of his new chair-making art.

To this unknown brother the *Sun* gives the New Year's gift of its assurance that there is an inexhaustible gold mine in the chair and seat we have endeavored to outline. But we solemnly warn him that, when he ceases to put his conscience, his pride, his ambition, and his hopes of the future into his work, and begins to cheapen it in a greed for quick wealth and unearned profits, the side walls of his golconda will swiftly draw together and he and his gold will be petered out.

Electric Notes.

A SHORT time ago the Julien Electric Company expressed a hope that by its new method of regulations it could so economize the use of the current from its battery as to make three round trips, or 36 miles, with one charge on the Fourth and Madison avenues line in New York. It now reports that this has been accomplished, and that the large 18-ft. cars, carrying unusually heavy loads of passengers, are now making three round trips, from 86th Street to the Post-Office and back (or 36 miles), without any change of battery. It now changes the battery but once a day, thus making a great saving in time. Not content with this performance, the Julien Company hopes to be able to make a fourth trip, or 48 miles, on one charge, inasmuch as it finds that at the end of the third trip the voltage of the battery is still above two volts per cell. It is claimed that the trip from 86th Street to the Post-Office and back, 12 miles, is made on an expenditure of less than 15 electrical H.P. hours, or 36 miles on 45 electrical H.P. hours. Calculating the cost at 2 cents per H.P. hour, the Julien Company computes that it costs but 30 cents for energy in a round trip of 12 miles, or 2½ cents per mile. Assuming 75 miles for a car-day the cost would be $1.87½. The Company gives these data from its books at their electrical station, and invites inspection, the records showing the ampère-hours and the H.P. hours put into the battery each day, and the cost of the same.—*Electrical Engineer.*

THE Thomson-Houston Electric Company has equipped the Cambridge Division of the West End Street Railroad, Boston, with its motor. This division extends from Bowdoin Square, Boston, to Harvard Square, Cambridge, three miles, and thence four miles further through North Avenue to Arlington. On the first division of three miles the traffic is large, and the cars run on a headway varying from one to two minutes. The overhead-wire system is used on this section, and 20 cars are to be equipped at the outset. Power is furnished from the station of the Cambridge Electric Light Company.

AFTER long delays, arising from legal obstacles, the conduits for the electric wires are now being put down on the cross-town railroad through Fulton Street in New York, and it is expected that the road will be in full operation early in the spring.

Blast Furnaces of the United States.

THE *American Manufacturer* thus sums up its detailed statement of the condition of the blast furnaces on January 1: "The totals are as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	71	13,213	97	11,386
Anthracite	108	31,837	88	22,297
Bituminous	154	97,117	71	31,964
Total	333	142,167	256	65,647

"Our table shows that the number of furnaces in blast on January 1 was 333, compared with 331 on December 1—an increase of 2. The charcoal furnaces show a decrease of 2, the anthracite an increase of 1, and the bituminous an increase of 3, making the net increase 2. The weekly capacity of the furnaces in blast was 142,167 tons, compared with 139,282 tons on the 1st of December. This shows a net increase of 2,985 tons—charcoal, decrease, 57 tons; anthracite, increase, 787 tons; bituminous, increase, 2,157 tons.

"The appended table shows the number of furnaces in blast on January 1, 1889, and on January 1, 1888, with their weekly capacity:

	Jan. 1, 1889.		Jan. 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	71	13,213	73	13,237
Anthracite	108	31,837	117	35,259
Bituminous	154	97,117	151	92,224
Total	333	142,167	341	140,720

"This table shows that the number of furnaces in blast on January 1 was 8 less than at the same date in 1888."

Manufacturing Notes.

RECENT shipments made by the Betts Machine Company, Wilmington, Del., include a large horizontal boring and drilling machine to the Louisville & Nashville shops at Decatur, Ala.; a large boring mill and a 60-in. planer to San Francisco; and two heavy frog planers, weighing 60,000 lbs. each, to the Ramapo Iron Works of Hillburn, N. Y.

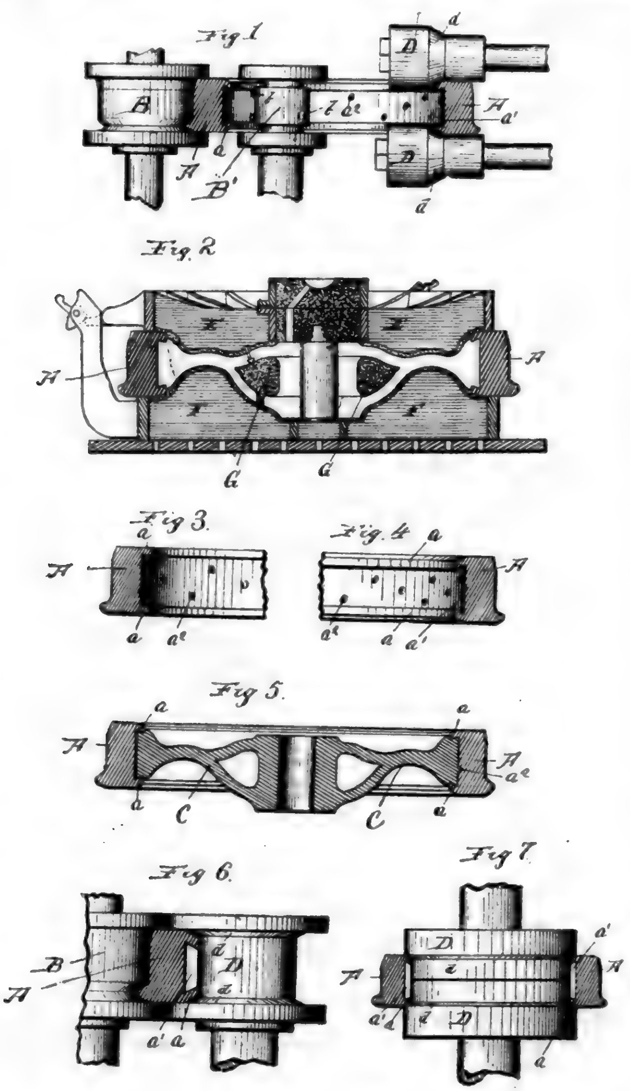
THE contract for the steel forgings for the 8-in., 10-in., and 12-in. guns for the Army has been awarded to the Bethlehem Iron Company, at Bethlehem, Pa., the price varying from 24 to 27½ cents per pound. The first set of 8-in. forgings is to be delivered within 18 months, and the work is to be finished in three years; the 10-in. forgings will require nearly five years, and the 12-in. forgings six years for their completion. The contract includes the steel for 21 guns of 8-in. caliber, 22 of 10-in., and 14 of 12-in. The Midvale Steel Company, Philadelphia, received the contract for 25 sets of forgings for 3.2-in. steel field guns at 35 cents per pound, delivery to be made within nine months.

THE Westinghouse Machine Company reports that its sales for the four months ending November 30 include 33 compound engines aggregating 4,070 H.P.; 88 standard engines aggregating 4,060 H.P.; and 141 "junior" engines aggregating 3,500 H.P., a total of 262 engines. The compound engines were mainly of large size, 26 of them being of 100 H.P. or over. The engines were furnished for almost every description of business, including machine shops, mills of all kinds, electric-light stations, hoisting engines, etc. These orders also include a number of engines for export to France, Russia, Cuba, and other countries.

New Method of Making Steel-Tired Wheels.

THE accompanying illustrations represent a method of making steel-tired car wheels in which the tire is first rolled and the center is cast within it. The inventor proposes to roll the tire, and to put it in the mold while still hot, so that no reheating will be needed. He prefers for the tire a hard and tough steel.

The invention is thus described : " Fig. 1 shows a sectional view of a tire and a pair of box-rolls in elevation, such as may be used for rolling the tire with the plain interior flanges, and also in elevation a pair of edging-rolls having bevelled collars suitable for use in turning down the flanges, so as to form a dovetailed groove. Fig. 2 shows a sectional view of the tire in the mold ready for pouring in the molten iron to form the cast center. Figs. 3 and 4 are cross-sections of the tire before and after the flanges are turned down to form the dovetailed groove. Fig. 5 is a sectional view of the wheel as produced by my process. Fig. 6 shows a single roll having a pair of conical collars,



and which operates, in conjunction with an ordinary box-roll, to incline the interior flanges of the tire. Fig. 7 shows a pair of dies with bevelled faces for pressing down the interior flanges of the tire. Similar letters of reference indicate like parts in all the figures.

" In the drawings, *A* represents the tire ; *a a*, the interior flanges ; *a'*, the interior dovetailed groove formed by inclining the flanges *a a* toward each other. The flanges are rolled upon the tire by box-rolls *B B'*. The interior box-roll, *B'*, is provided on its periphery with one or more small projections, *b*, which serve to make a number of indentations on the interior peripheral surface of the tire. The molten metal of the cast-iron center, *C*, flowing into these indentations a^2 in the tire, serves to more rigidly connect and fix the center and tire together.

" *D D* represent a pair of edging-rolls having bevelled shoulders, *d d*, adapted to bear against the flanges *a a* and bend or incline them toward each other. In fig. 6 a single vertical roll, *D*, having two bevelled shoulders or collars, *d d*, operates in conjunction with the box-roll *B* to accomplish the same purpose.

" In fig. 7 the tire, after being swung from the rolling-mill, is placed in a stamp or press between two dies, *D D*, having bevelled shoulders *d d*.

" The means indicated in fig. 1 are those preferred for inclining the interior flanges of the tire, as the pair of rolls *D D* may be attached directly to the rolling-mill the same as ordinary plain edging-rolls have heretofore been attached, and after the box-rolls *B B'* have done their work the rolling of the tire is completed and the rolls *D D* pressed against the tire the moment the interior box-roll, *B'*, is withdrawn.

" In fig. 2 the mold is shown ready for pouring. *E* represents the cope, *F* the drag, and *G* the interior of the core of the mold.

" The tire *A* forms a part of the mold, and is placed therein while still hot from the rolling-mill. After being rolled the tire is not reheated, the rolling of the interior of the flanges *a*, the inclining of said flanges to form the dovetailed groove, and the placing of the tire in the mold and forming the cast center therein being all effected in one and the same heat, so that the chill upon the outer periphery of the tire will not be injured by the casting operation. The casting of the center within the tire will not of itself so raise the temperature of the tire as to destroy or injure the chilled and hardened surface produced by the rolls upon the tread of the tire.

" The dovetailed groove may be formed on the interior periphery of the tire by bending or inclining only one of the two flanges instead of both. The preferable way, however, is to incline both flanges, as it makes a better shaped dovetailed groove than is made by inclining only one of them."

This method of making car wheels is the invention of James Munton, of Maywood, Ill., and is covered by patent No. 390,695, issued to him under date of October 9, 1888.

The Widdifield & Bowman Brake.

A TRIAL of this brake on the Lehigh Valley Railroad on January 10 was witnessed by a number of invited guests. The freight train equipped with the brake ran from Metuchen to Flemington Junction and back, making ordinary service stops, emergency and breakaway stops very successfully.

This brake is a momentum brake, with electrical attachment for throwing it into action simultaneously on every car on a train. The essential features of the brake consist of a composite sleeve cast on to the car axle, upon which work two friction pulleys, properly geared, and thrown into action by an impulse of electric current ; by these friction pulleys a chain gear is wound, which applies the brakes to the car wheels. The electricity is stored in cells, which are placed on the engine and rear car, and carried along the train by an insulated wire cable suitably coupled between each car.

The brake is controlled from either end of the train. In case the train is accidentally broken in the middle, the brakes apply all along the train automatically and in an instant, and the brakes on each section of the train can be released instantaneously, although the train is separated, as the independent electric circuits remain in each section, leaving absolute control of the forward section at the engine, and of the rear section at the caboose or rear car. Cars that are not fitted up with the brake may be taken into the middle of the train and switched out at will without interfering with the operation of the brake from either end of the train.

Marine Engineering.

THE Bowers dredger that has been built at San Diego is one of the largest ever constructed in this country. Its length is 120 ft., beam 32 ft. The drilling and pumping machinery is located in the stern, where there is a long shaft through which works an iron apparatus 27 ft. long and 77 in. wide.

Under it is suspended a 20-in. suction pipe, at the end of which works the Bowers excavator, consisting of a mammoth iron screw 4 ft. in diameter, which bores into the sand, throwing out a cubic yard of earth at each revolution. The propelling machinery is driven by a 30 H. P. engine. The ladder is lowered and raised by a 20 H. P. engine. On the left of the ladder near the center of the dredger is a suction pipe, which coming up from the screw at the bottom turns into a slip-joint, and is carried back to the center of the dredger, where the pipe connects with an immense circular pump 6 ft. in diameter, and rotating with a velocity of 400 ft. per minute. The pump is driven by a 250 H. P. Westinghouse engine, having a 20-in. cylinder and 16-in. stroke. This is the largest Westinghouse engine ever

built. The pump can force sand through pipes over a mile.—*Pacific Lumberman and Contractor.*

THE Centennial Transportation Company, of New York, are having a twin screw steamer built by J. Ellis & Son, of Tottenville, S. I., to run between Sea Bright and New York next season. Her dimensions are 105 ft. keel, 114 ft. over all, 21 ft. 6 in. hold, and estimated draught 3 ft. 9 in. light. She will have two sets of triple expansion engines, built by Sullivan, the high-pressure cylinders of which are 6½ × 10 in. They are expected to make 300 revolutions per minute, with 350 lbs. of steam, the steam to be supplied by a pair of Roberts' safety water tube boilers, having in the aggregate about 44 square feet of grate and nearly 1,300 square feet of heating surface. They will carry a working pressure of 250 lbs. of steam on natural draught.—*Marine Journal.*

THE W. & A. Fletcher Company has taken the contract for a new steel ferry-boat for the Union Ferry Company, of Brooklyn.

Locomotives.

THE Rogers Locomotive Works, Paterson, N. J., are building 18 locomotives, with 18 × 24-in. cylinders and 63-in. driving-wheels, for the Eastern Railroad of Minnesota.

THE Richmond Machine & Locomotive Works, Richmond, Va., are building additional shops and putting in new tools with the intention of increasing their capacity for building locomotives to 100 a year.

THE Cooke Locomotive Works in Paterson, N. J., being unable to secure additional room on the site at present occupied, have purchased land in a much more convenient location, adjoining the Erie tracks in Paterson, where they are now erecting extensive and well-arranged buildings for their shops.

DURING 1888 the Baldwin Locomotive Works, Philadelphia, largely exceeded any previous yearly output, the number of locomotives built being 737. Of these, two were of special types, one being a handsome locomotive and car combined for the Government of Nicaragua, and one a rack-rail locomotive for a Brazilian railroad. Of these engines 188 had two pairs of driving-wheels connected, 275 had three pairs of driving-wheels coupled, and 272 were of the consolidation type, with four pairs of coupled wheels. The latter included two locomotives with 21 × 26-in. cylinders and 21 with 22 × 28-in. cylinders. In all 93 locomotives were exported to the following countries: Australia, Brazil, Canada, Central America, Cuba, Ecuador, Mexico, and New Zealand.

THE Schenectady Locomotive Works furnish the following table showing the locomotives built by them in 1888:

Cylinders.	8-wheel.	10-wheel.	12-wheel.	Consolidation.	Switch. 6-wheel.	Switch. 4-wheel.
14 in.	....	....	....	....	....	1
15 in.	....	....	....	....	....	2
16 in.	....	....	....	....	....	10
17 in.	8	....	....	....	19	....
18 in.	81	94	....	....	19	....
19 in.	....	40	....	....	4	....
20 in.	....	....	13	10	....	....
Totals,	89	134	13	10	42	13

This is a total of 301 locomotives, the largest output ever made by these works in one year. The large proportion of heavy engines is noticeable. The average weight of these 301 engines, exclusive of tender, was 98,000 lbs. The works now employ about 1,500 men.

Cars.

THE Dunham Manufacturing Company, Boston, has made sales of its storm-proof car door recently to the Cleveland, Columbus, Cincinnati & Indianapolis, the Wabash Western, the New Jersey Central, the Union Pacific, and the Milwaukee, Lake Shore & Western roads. The same company reports recent sales of its Globe ventilator to the Boston & Albany, the New York Central, the Memphis & Charleston, and Pullman's Palace Car Company.

THE American Railway Equipment Company has been incorporated in New York for the manufacture of the Stearns patent car box and other standard improvements. The corporators are O. S. Burr, George G. Saxe, A. S. Hatch, Thomas R. White, Jr., O. S. Stearns, Herbert S. Ogden, and Hon. William Fullerton; O. S. Burr, President; A. S. Hatch, Vice-President and Treasurer; Thomas R. White, Jr., Secretary. The capital is $1,000,000.

THE St. Charles Car Company, St. Charles, Mo., did a business in 1888 of the value of $2,200,000, and expended $100,000 in improvements. Besides the passenger coaches and the 3,129 freight cars turned out, 3,000 car wheels were moulded, and 100,000 tons of cast and wrought-iron work completed.

THE Beal's Brake Company, of New York, has recently been reorganized. The newly elected officers are: President, T. B. Atkins; Secretary and Treasurer, R. W. Gilbert; Directors: W. D. Ellis, Dr. Cochran, and H. B. Hammond. Mr. James Howard is retained as General Manager for the new company.

THE South Baltimore Car Works are building for the Baltimore & Ohio Railroad 200 gondola cars, 34 ft. long, and 50,000 lbs. capacity. They will have the American continuous draw-bar. John B. McDonald has been chosen President of these works.

Bridges.

THE Phœnix Bridge Company recently completed a heavy iron bridge over Germantown Avenue, Philadelphia, for the Philadelphia & Reading Railroad.

THE St. Louis Bridge & Iron Company has recently taken several contracts for highway bridges, including one of 120 ft. span over Loutre Creek, in Montgomery County, Mo.

The Boyden Brake.

TESTS of this brake were made on the Baltimore & Ohio Railroad, December 17, 18, and 19. The first test was made with a train consisting of engine, 25 refrigerator cars, and two private cars, the total weight of train being about 590 tons. The weather was wet. A stop made at a speed of 39 miles per hour brought the train to a stand in 24 seconds, and a distance of 920 ft. on a descending grade of 80 ft. to the mile. On an ascending grade of 23 ft. at a speed of 24 miles, one stop was made in 250 ft., and other very good stops were made on level and slightly descending grades, the distance varying from 550 to 620 ft. On the second day a stop was made on a descending grade of 116 ft. to the mile, at a speed of 47 miles an hour, in 965 ft. In all 15 stops were made during these tests with excellent results. After the tests were made a careful examination showed that none of the car wheels were flattened.

The Boyden Brake comprises an air-pump, an air-reservoir on the locomotive, a valve to be worked by the engineer in his cab, a brake for the locomotive, a train-pipe, a pressure regulator to control the compressed air which enters the train-pipe, hose couplings between the cars, and the automatic spring brake device and valve on each car.

OBITUARY.

LIEUTENANT GOVERNOR JAMES H. MACDONALD; HORACE TUTTLE and WILLIAM S. COCHRANE, all of Escanaba, Mich., were killed January 19, by the derailing of a car on the Chicago & Northwestern Railroad, near Gogebic, Mich.

Mr. Macdonald was for a number of years connected with the Chicago & Northwestern road, but for several years past he had been engaged in the management of large iron mining properties in the Lake Superior Region. He was 57 years old, and had just entered on a second term as Lieutenant-Governor of the State.

Mr. Tuttle was also engaged in iron mining, and was President of the Commonwealth Iron Company. Mr. Cochrane was Manager of the works of the Cochrane Iron Mining Company.

PERSONALS.

JOHN B. INMAN is Chief Engineer of the Troy & Tiptonville Railroad, with office at Troy, Tenn.

SAMUEL ROCKWELL has been appointed Chief Engineer of the Eastern Railroad of Minnesota.

COLONEL WILLIAM J. WINN was on January 9 unanimously re-elected City Engineer of Savannah, Ga.

T. W. NICHOL, of Mobile, Ala., is now Chief Engineer of the Mobile, Jackson & Kansas City Railroad.

A. L. STANNARD is Chief Engineer of the Davenport, Iowa & Dakota Railroad, with office at Davenport, Ia.

F. D. WOODBURY, of Waseca, Minn., is Chief Engineer of the Minneapolis, St. Paul & Southwestern Railroad.

G. W. CUSHING has been appointed Superintendent of Motive Power of the Union Pacific Railway, with office at Omaha.

JOHN W. CLOUD has resigned his position as Superintendent of Motive Power of the New York, Lake Erie & Western.

GEORGE LINDOFF has been appointed Master Mechanic of the Montana Union Railroad in place of GEORGE ROSS, who has resigned.

ROSS KELLS succeeds Mr. JOHN W. CLOUD as Superintendent of Motive Power of the New York, Lake Erie & Western Railroad.

CLEM. HACKNEY has resigned his position as Superintendent of Motive Power of the Union Pacific Railway, after three years' service.

J. P. NELSON has been appointed Chief Engineer of the Newport News & Mississippi Valley Company, and has his office in Lexington, Ky.

SAMUEL M. ROWE has been appointed Chief Engineer on the Western Division of the Atlantic & Pacific Railroad, with office at Albuquerque, N. M.

W. H. LEWIS has been appointed Master Mechanic of the Chicago, Burlington & Northern Railroad, in place of H. S. BRYAN, who has resigned.

ARTHUR JOHNSON has resigned his position as Mechanical Engineer of the New York, Lake Erie & Western Railroad. He has been connected with the road for 25 years.

J. G. METCALFE has been appointed General Manager of the Louisville & Nashville Railroad, to succeed Mr. HARAHAN. He has been Superintendent of the South & North Alabama Division.

ALBERT SPIES, for seven years Mechanical Editor of the *Iron Age*, has severed his connection with that journal with the view of taking up professional work. He may be addressed at 901 Summit Avenue, Jersey City, N. J.

GEORGE W. W. HOUGHTON, for 20 years past Editor of the *Hub*, has retired from that journal, and is now Editor of *Varnish*. Mr. Houghton is thoroughly acquainted with the carriage business, and is a writer of ability.

S. B. OPDYKE, JR., late Engineer of Bridges on the New York, New Haven & Hartford Railroad, has been appointed General Superintendent of the Hartford & Connecticut Western Railroad.

JOHN T. RICH has been reappointed Railroad Commissioner of Michigan for another term. He has reappointed WYLLYS C. RANSOM Deputy Commissioner, and CLINTON B. CONGER Mechanical Engineer.

JOHN BLACK has been appointed Master Mechanic of the Chicago & Atlantic Railroad, with office at Huntington, Ind. Mr. Black was formerly on the Cincinnati, Hamilton & Dayton Railroad.

C. W. DAVENPORT has been chosen Chairman of the Erie Car Works, Erie, Pa., to succeed his father, the late WILLIAM R. DAVENPORT. He has been connected with the works for a number of years past.

WATERMAN STONE, for 17 years past Superintendent of the Providence, Warren & Bristol Railroad, has resigned that office to accept the position of General Manager of the Interstate Elevated Railroad at Kansas City.

LIEUTENANT BRADLEY A. FISKE, U.S.N., whose articles on Electricity will be remembered by our readers, is the inventor of the electrical apparatus which will be used in firing the dynamite guns on the new gunboat *Vesuvius*.

D. H. NEALE has accepted an important position in the locomotive department of the Government Railroads of New South Wales. Mr. Neale is well qualified for such a position by his experience and attainments as a mechanical engineer.

SAMUEL SPENCER, who recently retired from the office of President of the Baltimore & Ohio Railroad Company, has, it is stated, accepted the position of Vice-President and General Manager of the East Tennessee, Virginia & Georgia Railroad Company, and will be the chief executive officer in charge of that Company's extensive system of railroads.

PROCEEDINGS OF SOCIETIES.

National Geographic Society.—This society held its annual meeting for election of officers, presentation of reports, etc., December 28. The Secretaries and Treasurer presented their annual reports, and officers were elected for the year 1889 as follows: President, Gardiner G. Hubbard; Vice-Presidents, H. G. Ogden, G. L. Dyer, A. W. Greely, C. Hart Merriam, A. H. Thompson; Treasurer, C. J. Bell; Secretaries, Henry Gannett, George Kennan; Board of Managers, Cleveland Abbe, Marcus Baker, Rogers Birnie, Jr., G. Brown Goode, C. A. Kenaston, W. B. Powell, O. H. Tittmann, J. C. Welling.

American Geological Society.—A large number of geologists met at Cornell University, Ithaca, N. Y., December 27, in response to the call to organize a permanent society of geologists. A constitution was adopted, and the permanent organization will be known as the American Geological Society, its object being the promotion of the science of geology in North America. The society has 126 members, all of whom are working geologists.

These officers were elected: President, Professor Hall; Vice-Presidents, J. D. Dana and Professor Winchell; Secretary, Professor J. J. Stevenson; Treasurer, H. S. Williams, of Cornell. The membership of the society is to be limited to prominent geologists, and each member is to have the privilege of using the title F. A. G. S. (Fellow of the American Geological Society). The meeting was formally adjourned to meet in Toronto in the early part of next August.

American Institute of Mining Engineers.—The nineteenth annual meeting will be held in New York City, beginning Tuesday evening, February 19, 1889.

The following programme is provisionally announced:

Tuesday, February 19—Evening: Opening session.

Wednesday, February 20—Morning and Afternoon: General excursion to the Spiral Weld Tube Works and the Edison Laboratory, at East Orange, N. J., with a session at the Edison Laboratory devoted to the Applications of Electricity in Mining. A paper is promised from Mr. Edison.

Evening session devoted to papers and discussions connected with iron and steel.

Thursday, February 21—Morning and Afternoon: Sessions at which, if the Council so decides, the subjects of the Wednesday evening session may be continued. At the afternoon session the election of officers and other business will be transacted. Evening: Subscription dinner.

Friday, February 22—Morning and Afternoon: Numerous local excursions, in parties, according to the preferences of individual members. Evening: Social reception.

Saturday, February 23—Morning and Afternoon: Local excursions.

Mr. R. P. Rothwell, editor of the *Engineering and Mining Journal*, has special charge of the programme of the session of Wednesday, devoted to Electricity in Mining, and Mr. Charles Kirchhoff, Jr., editor of the *Iron Age*, has special charge of the programme of the session or sessions devoted to Iron and Steel. Members intending to present papers on these subjects should correspond with Mr. Rothwell or Mr. Kirchhoff, according to the nature of their papers, notifying the Secretary of the Institute also of their intention.

Society of American Naturalists.—This Society has chosen the following officers for the ensuing year: Professor George L. Goodale, Harvard University, President; Professor G. Brown Goode, Smithsonian Institution, Vice-President; Professor Henry H. Donaldson, Johns Hopkins University, Secretary; Professor William T. Sedgwick, Massachusetts Institute of Technology, Treasurer; Rev. J. P. McMurray, Haverford College, Professor George H. Williams, Johns Hopkins University, Executive Committee. A communication was read from the Zoological Society of Paris, stating that it is organizing an International Zoological Congress to convene about August 1, in some place not yet determined upon, and requesting the coöperation of all naturalists.

United States Naval Institute.—At the meeting held in Annapolis, January 4, Commander P. F. Harrington delivered a lecture on the Ram as a Naval Weapon. After an interesting statement of experience he reached the following conclusions as to future naval warfare :

"1. The torpedo-boat will be confined to operations in the immediate vicinity of harbors, and its usefulness will be limited, if not destroyed, by a moderate sea or swell.

"2. Whenever two or more ships are associated, the principal battle order will be formed by the heavier vessels of great offensive and defensive qualities.

"3. The tactics of the principal battle line will assimilate the long-recognized principles of fleet tactics, but modified by the presence of the ram and the torpedo. The unity and mutual support of this line will in general forbid the attempts of individual ships to employ the ram and limit them to the gun as the chief weapon.

"4. An auxiliary force will be associated with the principal battle line. From all the vessels of a naval force, smaller than the battleships and not otherwise suitable for a place in the battle line, those will be selected for auxiliaries which upon comparison are judged to possess the greatest speed and handiness, combined with the greatest protection to machinery and stability. These are the torpedo rams to be manœuvred by separate tactics. They will be with, but not of the line of battle."

Franklin Institute.—The subjects for the lectures in the regular course during February, are :

February 4 : Bearing Metal Alloys ; Dr. Charles B. Dudley.

February 11 : Amateur Photography ; Professor Charles F. Himes.

February 18 : Some New Points in Chemical Theory ; Dr. T. Sterry Hunt.

February 25 : Blindness and the Blind ; Dr. L. Webster Fox.

American Society of Civil Engineers.—At the regular meeting of December 19, a communication was read from the English Society of Arts extending an invitation to the American Society of Civil Engineers to visit them next year.

The Secretary announced that Dr. Wolfred Nelson would deliver a lecture on the Panama Canal, December 21, in Chickering Hall. The Secretary exhibited photographs of specimens of timber that had been treated by various processes, and read an accompanying report.

Francis Collingwood, J. F. Flagg, Theodore Cooper, and John Bogart discussed the ravages of the teredo and the details of the protective processes. Subsequently State Engineer John Bogart exhibited drawings of three types of lift-bridges over the Erie Canal.

AT the regular meeting of January 2 the topic of the evening was the discussion of High Dams to Resist the Pressure of Water. A discussion was read by E. Sherman Gould, and one was read by the Secretary for Professor E. A. Fuertes. These discussions related mainly, if not entirely, to the paper on High Dams, read some months before by James B. Francis, but the oral discussion that followed gravitated to the question of curved dams in general and the proposed Quaker Bridge Dam in particular. Messrs. Buck, Collingwood, Croes, Davis, Emery, Flagg, Fteley, Wellington, and Whistler, took part, and the discussion was quite animated.

The following gentlemen were announced as elected :

Members : Winthrop Bartlett, St. Louis, Mo. ; Charles Addison Ferry, New Haven, Conn. ; John Leland FitzGerald, Greenbush, N. Y. ; Charles Wingate Gibbs, Silverton, Col. ; Edward A. Handy, Cleveland, O. ; George Alexander Keefer, Victoria, B. C. ; James Warren Pearl, Canton, O. ; John Charles Quintus, Erie, Pa. ; Lewis F. Rice, Boston, Mass. ; William Benson Storey, Jr., Carbonado, Wash. ; William Henry Wentworth, Monterey, Cal. ; Nuevo Leon, Mexico.

Associate : John Elfreth Watkins, Washington, D. C.

Juniors : Ysidori Ygnacio Polledo, Cardenas, Cuba ; Charles St. John Warner, New York City.

THE 36th annual meeting began at the Society's house in New York, January 16. The report of the Committee on Standard Time was presented by Mr. Sandford Fleming, who reported progress made toward securing the adoption of the 24-hour notation for time.

A paper discussing the report of the Committee on the Relation of Car Wheels to Rails was presented by Mr. Don M. Whittemore.

It was announced that the British Institution of Civil Engineers had offered its services to the delegation of the American Society, which will attend the Paris Exposition. Other routine business was transacted.

It was announced that the Rowland prize of $50 had been awarded to Clemens Herschel, of Holyoke, Mass., for his paper on the Venturi Water-Meter. The Norman gold medal has been awarded to E. E. Russell Tratman for his paper on English Railroad Track.

The following officers were announced as elected for the ensuing year : President, M. J. Becker, Pittsburgh ; Vice-Presidents, A. Fteley, New York, and E. L. Corthell, Chicago ; Secretary and Librarian, John Bogart, New York ; Treasurer, George S. Greene, Jr., New York ; Directors : Charles B. Brush, New York ; Eliot C. Clarke, Boston ; Walter Katte, New York ; Robert E. McMath, St. Louis, and William P. Shinn, Boston.

On the second day of the meeting the morning was spent by the members present in visiting the new Manhattan Bridge over the Harlem River, the yards and other works of the Dock Department, the freight transfer stations of the New York Central Railroad, the Brooklyn Bridge, and the new gas-holder of the Consolidated Gas Company, which is said to be the largest in the world. In the afternoon a meeting was held, at which a number of papers were presented.

The evening was devoted to the annual reception of the Society, at which a large number of members and invited guests were present.

The Engineers' Club.—The regular meeting of this Club was held in New York, January 15, Vice-President Henry R. Towne in the chair. There were between 50 and 60 members present.

Mr. Towne stated briefly the objects of the Club and the business of the meeting, and announced that the election of officers would be deferred till a later meeting.

Resolutions offered by Dr. Egleston were adopted, authorizing the present Board to provide suitable quarters for the Club. There was some informal discussion on the location of the clubhouse. Mr. Williams, the Secretary, read a list of the gentlemen already members, and announced that a number of others had signified their wish to join the Club.

Canadian Society of Civil Engineers.—At the annual meeting in Montreal, January 17, the retiring President, Mr. T. M. Keefer, presented his annual address. The following officers were elected : President, Colonel C. S. Gzowski ; Vice-Presidents, E. P. Hannaford, H. F. Perley, P. A. Peterson ; Treasurer, H. Wallis ; Secretary, H. T. Bovey ; librarian, F. Chadwick. Members of Council : J. D. Burnett, H. Blackwell, F. N. Gisborne, J. Kennedy, G. F. Baillairge, St. G. Boswell, E. Gilpin, M. Murphy, E. Wragge, M. J. Jennings, F. R. F. Brown, B. D. McConnell, J. E. Vanier, and G. A. Keefer.

New England Water-Works Association.—An adjourned meeting was held in Boston, January 16. A paper by William B. Sherman, of Providence, on the subject of Safe Ratio of Pumping Capacity to Maximum Consumption, which was read at the last meeting, was discussed by Messrs. William R. Billings, Dexter Brackett, Frank L. Fuller, A F. Noyes, J. Herbert Shedd, Mr. Sherman, Edwin Darling, W. M. Hawes, and L. Fred Rice.

Mr. L. F. Rice replied to criticisms that had been made of a paper read by him on the subject of Testing Water-Meters. He defended the methods adopted by the commission of the city of Boston in the tests made several years ago. Mr. E. R. Jones described his experience in the use of water-pipes coated with rosin for the purpose of preventing freezing.

Engineers' Club of Philadelphia.—A regular meeting was held December 15. The Secretary presented, for Mr. J. Milton Titlow, some historical particulars with regard to the old Market Street Bridge, Philadelphia, with an electrotype of the copper plate found at low water level in the middle of the east pier, when it was taken down to be rebuilt above low water for the present iron cantilever bridge.

Mr. F. J. Amweg exhibited photographs of the piers when the rebuilding was being started, and gave some account of the substantial character of the old work, etc.

Mr. Arthur Marichal presented—as a discussion of Professor L. M. Haupt's recent paper on the Plans for the Proposed Improvement of the Bar at the Entrance to the Rio Grande do Sul, Brazil—a description of the Improvements of the Harbor of Libau, Russia.

Professor H. W. Spangler, Mr. Arthur Marichal, and the Author, Mr. J. E. Codman, continued the discussion of Indicator Cards from Compound Engines Showing Expansion through High and Low Pressure Cylinders.

The Secretary presented, for Mr. Robert A. Cummings, a Table of Radii of Curves in Inches, for the *Reference Book*.

The Secretary presented, for Mr. Michael Trump, an illustrated paper on Interlockings, Pittsburgh Yard, Pennsylvania Railroad.

Mr. G. D. Chenoweth presented an illustrated description of the Chenoweth Conduit for Electric Wires.

THE annual meeting was held in Philadelphia, January 12. The Secretary and Treasurer presented his annual report, showing that at the end of 1888 there were a total of 2 honorary, 497 active, and 13 associate members, an increase of about 8 per cent. during the year. The total receipts were \$4,746, and the expenditures, \$4,032, the net cash assets of the Club being \$2,454.

President Joseph M. Wilson called the attention of the Club to prospective efforts to interfere with the excellent organization of the United States Coast and Geodetic Survey.

Professor Arthur Beardsley presented a preamble and resolutions urging upon the Government the great importance and desirability of maintaining both the present status of the Survey and the methods by which its management is selected.

Professor L. M. Haupt seconded these resolutions, and after several members had spoken upon the subject, the preamble and resolutions were adopted.

The retiring President, Mr. Joseph M. Wilson, delivered the annual address, which was devoted to an historical account of bridges from the earliest times on record to the present day. A large number of the more notable constructions, in wood, stone, iron, and steel, were specifically mentioned. Some account was given of the history of the manufacture of iron and steel, and their particular advantages in bridge construction, resulting in their almost universal use for the building of the permanent bridges of the present day. Questions of failures were also considered, and suggestions made in reference to this subject.

The tellers announced that the following officers had been elected: President, William Sellers; Vice-President, Professor Arthur Beardsley; Secretary and Treasurer, Howard Murphy; Directors: T. M. Cleemann, Frederic Graff, Professor L. M. Haupt, Washington Jones, and Joseph M. Wilson.

President-elect William Sellers was unable, on account of illness, to be present, so Vice-President-elect Arthur Beardsley took the chair, with appropriate remarks, and the fiscal year 1889 was duly opened.

Engineers' Club of Cincinnati.—The regular monthly meeting of the Club was held January 2. The Executive Board presented their annual report for the year 1888, which was accepted.

Mr. Whinery, who was connected with their location and construction during a part of the period required in the same, gave the Club an entertaining description of the Inclined Plane and the Broad Gauge Railroad, recently built to the top of Lookout Mountain at Chattanooga. The Inclined Plane presents some peculiar and interesting features from the fact that a large portion of the distance is on a curve. He also gave a short description of the railroad built up Mission Ridge in the same locality. This road, although only about 2¾ miles in length, has very heavy grades and curves, and requires an engine of special construction to operate it.

The peculiar feature of this engine is that it has three vertical cylinders all on one side, engaging by gearing with a horizontal shaft, which in turn connects with the drivers by gearing.

Mr. Whinery exhibited several drawings and photographs to illustrate his subject.

Civil Engineers' Society of St. Paul.—The regular meeting was held January 7.

President Loweth made an address on the best method of increasing the usefulness of the Society.

Mr. W. W. Curtiss read a paper upon the Stand-Pipe for Water-Works.

The following officers were elected for the ensuing year: President, Charles F. Loweth; Vice-President, S. D. Mason; Secretary, George L. Wilson; Treasurer, F. W. McCoy; Librarian, A. Munster.

Minneapolis Society of Civil Engineers.—At the annual meeting, January 2, the election of officers resulted as follows: President, W. A. Pike; First Vice-President, G. A. Sublette; Second Vice-President, F. C. Deterly; Secretary, W. R. Hoag; Assistant Secretary and Treasurer, C. A. Huntress; Librarian, W. W. Redfield. W. A. Pike read a paper on the Quaker Bridge Dam, and W. R. Hoag one on Solar Attachments to Transits.

Iowa Society of Surveyors & Civil Engineers.—This Society was formed at a meeting held in Des Moines, Ia., January 9, by the consolidation of the two organizations previously existing, the Iowa Society of Engineers and the Iowa Society of Surveyors. The headquarters of the Society are to be in Des Moines, where the meetings will be held and a professional library will be collected. The officers of the new Society are as follows:

Ed. Gilchrist, of Keokuk, President; Seth Dean, Secretary; F. A. McDonald, Treasurer; M. Tschirgi, Dubuque, Vice-President; M. R. Laird and Charles Bennett, Directors.

The technical business of the meeting consisted of a paper on Water-Ways, read by President Gilchrist, and of a general discussion on sewer and drainage pipes.

Engineers' Club of St. Louis.—At the regular meeting of December 5, William F. Schaefer, Louis Simonds, and H. D. Wood were elected members.

Professor J. R. Kinealy's paper on Condensers for Steam-Engines was then read by the Secretary. The resulting economy of fuel was explained, also the principal features of jet and surface condensers. By using condensers the work that an engine would do could be increased; or, if doing the same work, either the initial pressure could be reduced or the point of cut-off made earlier. Tables showing the results that might be expected at various pressures and cut offs were submitted. This was followed by a long and interesting discussion.

AT the regular meeting of December 19, the result of the election for officers was announced as follows: President, Edward D. Meier; Vice-President, Francis E. Nipher; Secretary and Librarian, William H. Bryan; Treasurer, Charles W. Melcher. Directors, M. L. Holman, James A. Seddon. Member Board of Managers of the Association of Engineering Societies, J. B. Johnson.

Isaac A. Smith then read a paper on Changing the Gauge of the Ohio and Mississippi Railway. This work was done in the spring and summer of 1871. The length of main line from Cincinnati to East St. Louis was 340 miles, branches, 52; total, 392. The original gauge of 6 ft. was changed to 4 ft. 9 in.

President Meier called the Club's attention to the proposed monument to Captain Eads. In his opinion it was very desirable that the Engineers' Club of St. Louis should inaugurate a movement in this direction. Colonel Meier and Professor Engler were appointed a committee to look into the feasibility of erecting such a monument.

AT the regular meeting of January 2, several new members were elected:

The Committee on Highway Bridges presented a report favoring the supervision of those structures by a State engineer, but opposing the adoption of standard specifications. This report was adopted as the sense of the Club, and the Committee discharged.

Mr. R. E. McMath called attention to the desirability of collecting and contributing engineering publications for the benefit of the Club's library.

Mr. N. W. Eayrs then read a paper on the Interlocking System of the St. Louis Bridge & Tunnel Railroad. The present system had been in use since 1883. Three stations were operated, one large one in East St. Louis, and two smaller ones in this city. An air-compressing plant was operated at the east pier of the bridge. The compressed air was carried to the three stations, where it was used to operate pumps, which maintained a pressure on a second system of pipe-work, by means of water in the summer, and a solution of chloride of calcium in the winter. A detailed description was given of the workings of the different parts of the system. There was no loss of fluid, except by leakage, which was small.

Mr. Thomas McMath then presented a paper on the Peculiarities of the Citizens' Cable Railway, which was followed by a general discussion.

Engineers' Club of Kansas City.—At the regular meeting of January 7 a committee was appointed to arrange for a banquet. The Secretary was directed to correspond with other associations with reference to transfers of membership. F. C. Gunn was chosen a member, and William B. Knight was chosen to represent the Club on the Board of Managers of the Association of Engineering Societies.

The following officers were declared elected for the ensuing year: President, O. B. Gunn; Vice-President, W. H. Breit-

haupt; Secretary, Kenneth Allen; Treasurer, F. W. Tuttle; Librarian, Frank Allen; Directors, Wynkoop Kiersted, S. H. Longe.

The retiring President, William B. Knight, read an address. It was advised to make efforts to enlarge the list of associate members, and to add associates and honorary members. The benefit of united action in local societies in bringing about uniform standards, measures, methods of work and legislation was urged. The Club had taken active measures with regard to National Public Works and Bridge Reform, and it was thought much could be accomplished in the conduct of municipal work.

The thanks of the Club were presented to Mr. Knight for his services.

New England Railroad Club.—At the regular meeting in Boston, January 9, a communication was received inviting the members to attend a social meeting of the Central Railroad Club at Buffalo.

The subject for the evening was the Metric System of Weights and Measures. The discussion was opened by Mr. George Richards, and was continued by Messrs. Brooks, Marden, Allen, Coleman, and others, the general weight of opinion among the speakers being in favor of the metric system.

At the close of the discussion resolutions were adopted recommending that the Executive Committee of the Master Car Builders' Association appoint a committee on the Metric System to report at the next annual meeting of the Association.

Western Railway Club.—At the regular meeting in Chicago, January 15, a paper on Anti-Friction Metals was read by Mr. F. F. Bennett, of Chicago, who treated the subject at considerable length. This paper called out a lively discussion, in which interesting facts were given in regard to the wearing qualities of different alloys and the wear of journal brasses. Messrs. Rhodes, Sargent, Barr, Higginson, Sceets, and Townsend took part.

This subject having been closed, a paper on Car Heating was read by Mr. J. H. Setchel, arguing strongly in favor of the steam heating of cars. This was followed by another paper on the same subject by Mr. Johnson, the inventor of the Johnson heater. Mr. C. A. Schroyer spoke at length upon the results obtained with steam heating of trains of the Chicago & Northwestern Railroad during the present season, and a brief discussion on the same point concluded the meeting.

New York Railroad Club.—At the regular meeting, held January 17, the subject of Car Wheels was continued, with special reference to the adoption of a standard wheel and axle for 60,000-lbs. cars.

A paper on this subject was read by Mr. W. T. Hildrup, General Manager of the Harrisburg Car Manufacturing Company, who treated the subject with special reference to the wheels. Another paper on Axles was also read, and this was followed by a general discussion of the subject. The meeting was largely attended.

Northwest Railroad Club.—The organization of this Club was completed at St. Paul, Minn., December 15, when the following officers were elected: President, W. T. Small; Vice-Presidents, W. T. Reed, G. F. Wilson; Secretary, H. P. Robinson; Treasurer, H. L. Preston.

A REGULAR meeting was held in St. Paul, January 5, at which there was a long and interesting discussion on Snow Plows and Flangers, opened by Mr. C. F. Ward, and joined in by nearly all the members present.

NOTES AND NEWS.

The Torpedo Boats of the World.—The following is a brief statement of the strength of the different navies in this class of vessels: Those characterized as deep-sea craft are over 130 ft. in length; first class, from 100 ft. to 130 ft.; second class, less than 100 ft.; and the third class, steam launches and cutters.

England has of deep-sea class 2, first class 49, second class 80, third class 420, and 10 first class in process of construction.

France has of deep-sea 5, first class 20, second class 50, third class 129, and 5 deep-sea and 42 first class in process of construction.

Italy has 2 deep-sea, first class 38, second class 23, third class 150, to be increased to 250 by 1898, and 2 deep-sea and 43 first class in process of construction.

Russia has of deep-sea 2, first class 23, second class 34, third class 138, and 2 deep-sea and 3 first class in course of construction.

Germany has of deep-sea 3, first class 47, second class 48, and 2 deep-sea and 19 first class in process of construction.

Austria has of deep-sea 2, first class 18, second class 8, and 2 deep-sea in course of construction.

Turkey has of first class 19, second class submarine 2, deep-sea 2, and 19 first class in process of construction.

Spain has of deep-sea 6, first class 7, second class 2, and 50 to be built.

Greece has 6 deep-sea and 31 second class, of which 2 are submarines.

Denmark has 5 first class, 11 second class, 5 mining boats, and 14 first class and 14 second class in course of construction.

Norway and Sweden have 12 first class, 6 second class, and 1 mining boat.

Holland has 3 first class and 20 second class.

Portugal has 3 first class, 2 second class, and 3 first class in course of construction.

Japan has 1 armored, 4 first class, 4 second class, and 17 first class in process of construction.

China has of deep-sea 1, first class 1, second class 17, and third class 6.

Brazil has 5 first class and 15 third class.

Argentine Republic has 4 second class.

Chili has 4 second class.

The English colonies have 2 deep-sea, 1 first class, and 3 second class.

With the exception of the torpedo vessel now building at the Herreshoff yard and the *Stiletto*, recently purchased from the same company, the United States possesses no vessel intended wholly for torpedo warfare. This, of course, has no reference to the numerous torpedo launches carried aboard ship and fitted with the ordinary spar appliance, as commonly used at the Newport Torpedo School and on the launches at the Naval Academy.

New Station at Lockport.—One of the handsomest stations on the New York Central is soon to be built at Lockport, N. Y. It will be of Buffalo pressed brick, trimmed with light gray Medina sandstone, with a tower, an antique chimney, and Bangor dark-blue slate roof. The total length will be 128 ft., width, 34 ft. Large handsome porticoes in Mexican style will be placed on three sides. The windows will be dormer with stained glass. The interior walls are of red pressed brick with red mortar, and all woodwork is in white oak.

A gigantic fireplace and mantel will be one of the chief ornaments. It will be of terra-cotta, red slate, and encaustic tile, with andirons, shovel, tongs, poker, and fender guards. The building will be lighted by electricity and gas, and heated by steam.

A German Dynamite Gun.—It is stated in French papers that a dynamite gun made in Germany has been tried at Kiel. This gun has a caliber of 305 mm. (12 in.), and is 22.86 meters (75 ft.) long.

The description given is not very definite, and there may be some mistake about the length. The target at which the gun was fired was an old hulk, placed at a distance of 1,930 meters (6,330 ft.). The first shot was made with an unloaded shell to get the range; the second and third shots were each with a shell loaded with 598 lbs. of nitro-gelatine, and completed the destruction of the target.

New Bridge at Cincinnati.—On December 25 last the first train passed over the new Chesapeake & Ohio Bridge over the Ohio River, at Cincinnati.

The bridge is 5,320 ft. long, and, including all approaches, 17,000 ft. in length. It has two spans of 490 ft. each, and one of 550 ft. It is double-tracked for railroad trains, has wagon and street-car ways 11½ ft. wide, and foot passages 5 ft. wide.

It is calculated to bear the following strain: Two consolidation engines and tenders, with 14 ft. base, weighing each 104,000 lbs., coupled, on each track, followed by a uniform weight of 2,500 lbs. per lineal foot for the entire length of the structure; the concentrated weight of 30,000 lbs. on 10 ft. of each wagon-way, followed by a uniform weight for the whole length of 80 lbs. to the square foot, or about 900 lbs. to the lineal foot; on each foot-way 500 lbs. per lineal foot from end to end. A wind pressure of 30 lbs. to the square foot on the entire surface, including cars, has been provided for.

The total cost of the structure, including real estate, was a little over $5,000,000. Ground was broken for the first caisson in June, 1887, and work in iron was begun in March, 1888.

The bridge was built by the Phœnix Bridge Company, and, according to the *Cincinnati Gazette*, from which this account is condensed, the other contractors were, for the pneumatic work, Sooysmith & Co., of New York; and for the masonry, Mason,

Hodge & Co., Frankfort, Ky., and D. Shanahan, Louisville, Ky.

Superintendent Epes Randolph has had general supervision for the constructing company, with Captain A. H. Sawyer as Resident Engineer. For the bridge company's work Engineer J. S. Deans has been responsible, with General Foreman A. B. Millekin as First Assistant.

Friction of Locomotive Slide Valves.—At a recent meeting of the English Institution of Civil Engineers, a paper on this subject was read by Mr. J. A. F. Aspinall, in which he stated that only scanty data existed as to the friction of slide valves, and that the few experiments which had been made were not of a very satisfactory character. Hence he was led to design an apparatus for graphically recording the force required to move slide valves during the whole of their travel. The apparatus consisted of a small hydraulic cylinder and piston, which was made to form part of the valve link. An ordinary steam-engine indicator was screwed on to one end of this cylinder, and an air valve was placed on the other. For pulling, the indicator was on one end of the hydraulic cylinder. For pushing, it was placed on the other end. A second indicator on the valve-chest gave a simultaneous diagram of the pressures on the back of the valve. The pressure on one side of the hydraulic piston being atmospheric pressure, that shown by the indicator at the other end was the force required to move the slide valve, less any friction of the apparatus. The Author described the experiments made to determine the friction. The results showed that the relation between the pull or the push on the valve, and the pressures recorded by the indicator, could be expressed by a simple linear equation:

$$L_1 = 5.6 + 11.26\,L,$$

where L_1 was the pressure due to the force required to move the valve, and L the pressure shown by the indicator. The results of experiments with the apparatus on an ordinary brass valve, a brass Allen valve, and a cast-iron valve, were then given, both with the link in full forward gear and with the link notched up. A small excess of the pushing pressures over the pulling pressures was shown to be due to the steam pressure on the back end of the spindle. Samples of the diagrams and calculations were submitted. As the valve resistance was not uniform throughout the stroke, the causes of variation were discussed. These were the variation of pressure on the back of the valve, the variation of pressure on the face of the valve, the variation of pressure in the exhaust space, and the inertia of the parts in motion. As the most convenient measure of the valve resistance, the Author took, not the mean resistance of the valve, but the resistance at midstroke, and he compared his results with the few experiments previously made. The Author's results made the valve resistance considerably less than it had been supposed from previous experiments. He found the resistance of a valve in motion, with 127 lbs. to 139 lbs. pressure on the back, to range from 982 lbs. to 1,321 lbs. The valve was 16½ in. by 10 in. Taking one case, the total load on the back of the valve was 22,110 lbs.; the relieving pressure on one steam port, 1,800 lbs.; the relief due to steam in the valve passage, 980 lbs.; and the relief pressure on the exhaust area, zero. Hence the resultant load was 19,330 lbs. The force necessary to move the valve was 1,321 lbs.; the co-efficient of friction was therefore 0.068. Similar calculations for two other valves gave co-efficients of friction of 0.054 and 0.051. The lowness of the co-efficient of friction was remarkable, especially as the temperature of the surfaces must be about 350° Fahrenheit. The Author calculated the percentage of power lost in slide valve friction at 1.34 to 2.26.

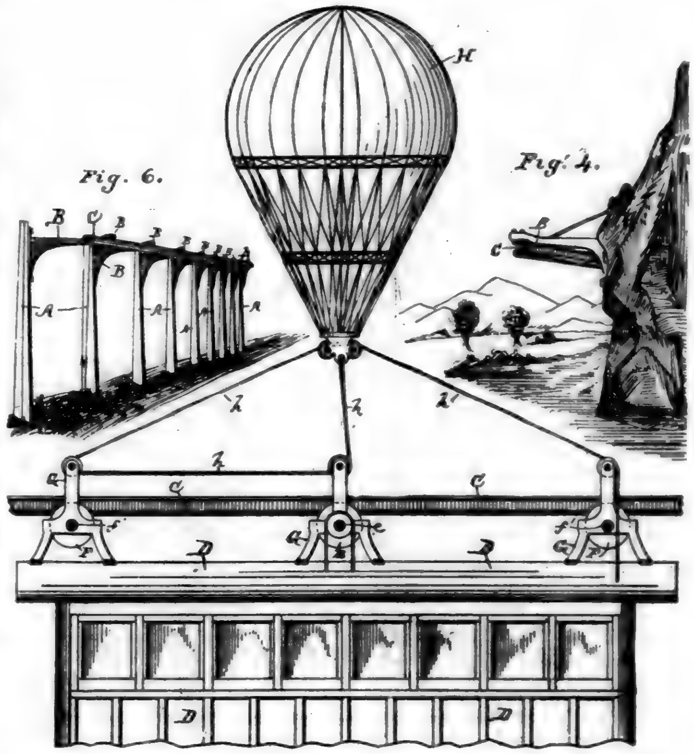
A Reversed Elevated Railroad.—The accompanying illustration shows what may be called one of the curiosities of the Patent Office, a device in which the inventor, with a sublime disregard of natural laws, proposes to dispense with gravity as a means of securing adhesion and, instead of running his train *upon* the track, to run it *underneath*, employing outside means to hold his car or locomotive up to the track.

The patent, which is No. 392,632, is granted to Robert T. Oney, of Charleston, W. Va., and is for an improvement in elevated railroads, which consists in suspending the car by means of a balloon, using the track only for purposes of traction and as a guide to the car.

The invention consists of a peculiar construction and arrangement of a locomotive having drive and guide-wheels held firmly against the traction surface of an overhead center single rail by the lifting force of an aerostat.

In the accompanying drawing *A A* are ordinary posts or standards, from which brackets, *B B*, project horizontally, and to the under surface of these brackets an inverted rail, *C*, is attached. A motor-car, *D*, arranged in any familiar manner, to be operated by steam, caloric, electricity, or any other suitable force, runs below the rail, having a drive-wheel, *E*, and guide-wheels, *F F*, to keep the wheels to the rail. From the

Fig. 1.



axles *e* and *f′ f′* of the several wheels coupling-rods, *G G*, rise into the air. To the upper ends of these rods an aerostat, *H*, is flexibly attached by ropes, chains or other equivalent attachments, *h h*, which can be payed out or hauled in as wind-currents or other circumstances may determine.

The French Navy.—From 1873 to the present time the growth of the French Navy has been as rapid as it has been steady; and the progress made in dockyard construction and the establishment of naval ports has been fully commensurate with the developments of the day.

Notwithstanding their impoverished condition at the close of the war, the French managed to obtain money, and began, at enormous expense, the first vessels of the navy that they to-day possess; and their success is due to the fact that they bent all their energies upon the building of the best armor-clad fighting ships and of the fastest and most powerful cruisers.

The last Parliamentary returns, dated June, 1888, showed that the French have 25 modern fighting ships, against 17 in the British service, and the fact that two-thirds of the 25 modern French fighting ships could singly blow any of the British Mersey class out of the water renders the great body of the British naval establishments of little importance in the event of war with France. The importance of the French Navy becomes even more evident when we consider that France is not dependent on her colonies for the supplies necessary to the preservation of her people. In the event of war she can draw on neighboring foreign territory for such commodities as her own vast resources fail to yield.

The following is a classified list of the most important of the vessels in the active list of the French Navy:

Iron-clads	18
Cruisers (iron-clads)	10
Guardships (iron-clads)	11
Gunboats (iron-clads)	4
First-class cruisers (protected class)	9
Second-class cruisers (protected class)	15
Third-class cruisers (protected class)	15
Torpedo cruisers (protected)	1
Sea-going torpedo boats	9
Gunboats (protected)	18
Steam sloops (protected)	12
Training ships and gunnery vessels	40

The *Admiral Baudin*, the largest vessel in the list, has a maximum speed of 15 knots an hour, a displacement of 11,380 tons, has 22 inch of armor, and carries three 14⅝ in. and twelve 5½ in. guns. This vessel is considered by many a more handy craft than the heavy *König Wilhelm* of the German Navy, but possesses many disadvantages by reason of her great tonnage.

Other powerful vessels are the *Duperre*, the *Indomitable*, the *Hoche*, and the *Courbet*.

Aside from the iron-clad list there are two vessels in the unarmored class worthy of notice. They are the sister-ships *Duquesne* and *Tourville*, each of 17 knots speed. They are each 329 ft. in length, and 51 ft. in beam, with a displacement of 5,700 tons. Their armaments consist of 21 guns to each vessel, 14 being 5½ in. and seven of 7½ in. calibre.

Electric Subways in New York.—The second annual report of the Board of Electrical Control of New York City informs the Governor that the total length of trench excavated in the city for the laying of subways is 240,155 ft. The total construction of single duct for telephone and telegraph service is 2,287,880 ft., less 325,429 ft. for distributing service and connections. Estimating 80 wires per single duct, the total capacity for telephone and telegraph service is about 34,665 miles of wire. The capacity of the conduits for lighting and power service is estimated at nearly 600 miles of wire. These figures are exclusive of the Edison conduits.

The number of poles removed is given as 776, and 946 miles of wire have been taken down. The Metropolitan Telephone & Telegraph Company, the Western Union Company, the Brush Electric Light Company, the Edison Electric Light Company, and the New York City Fire Telegraph have 4,453.52 miles of wire under ground. It is admitted that there are to-day in the city more overhead conductors than there were a year ago. It is intimated that in the business of arc lighting alone the increase during the year has been more than 200 per cent. The very large number of permits given by the Board to the various companies in streets where there are no subways shows an enormous increase in that direction also.

The Board is of the opinion that where companies fail to make use of the subways provided within reasonable time their poles and wires should be summarily removed from the streets. This power and responsibility are vested in the Mayor and Commissioner of Public Works.

Trans-African Railway.—Robert S. Newton, Vice-Consul at St. Paul de Loando, reports to the State Department that on October 31 the first section, 45 kilometers, of the Royal Trans-African Railway, from Loando to Ambaca, was opened to the public. Mr. Newton says:

"The line passes through districts alternating between large tracts of prairie, wooded hills, and fertile valleys watered by rivers and streams. The country about the margins of these rivers is already cultivated, both by natives and Europeans, and produces fruit in abundance, vegetables, sweet potatoes, and large quantities of sugar-cane. With the facilities now offered by the railroad for the carriage of machinery and materials for building purposes there is every prospect in the near future of the large tracts of uncultivated land being made to yield their quota of agricultural produce.

"There are proofs at hand of the utility of this enterprise to the commercial community generally and to the agriculturist in the interior.

"Large quantities of coffee are stored in the district of Cazengo owing to the want of carriers. Thus the produce is tied up to the serious loss of both agriculturists and merchants here. The coffee market in Europe is much better now than it has been for several months, but the merchants here are simply debarred from taking advantage of it, as they cannot get the coffee off the plantations, and in the mean time they not only lose a good market but interest is running on the capital so locked up. If the railroad were completed to this district all such risks would be completely done away with. If, now that they have commenced, they will go ahead and carry the line to completion as quickly as possible, the prosperity of the province would be assured. They have, however, a rather difficult country to go through before they reach Ambaca, and there is not much prospect of the line being completed within three years."

Cast-Iron Lighthouse Tower.—The accompanying illustration shows an elevation and section of a cast-iron lighthouse tower erected at Gibb's Hill, Bermuda; the lantern, which rests on the platform at the top, is not shown.

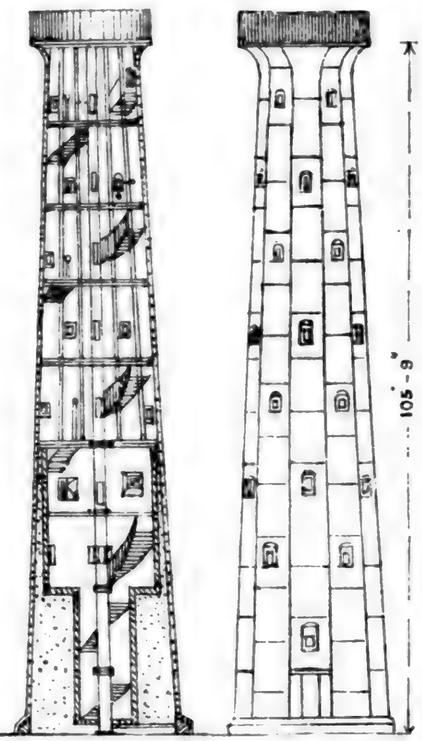
The form of this tower, the base of which is 245 ft. above the level of the sea, is that of a strong conoidal figure 105 ft. 9 in. in height, terminated at the top by an inverted conoidal figure 4 ft. high instead of a capital.

The external shell of the tower is constructed of 135 concentric cast-iron plates, including those for the doorway. These plates vary in thickness from 1 in. at the base to about ¾ in. at the top; they have cast-iron flanges on the inside 4 in. broad, including the thickness of the plate, and are further strengthened at intervals of 12 in. by angular feathers ½ in. thick. Holes are drilled in all the vertical and horizontal flanges 6 in. apart, and the plates are united to form the tower by square-headed screw-bolts ¾ in. in diameter with nuts and washers. In the center of the tower there is a hollow column of cast iron 18 in. in diameter in the inside, the thickness of the metal being ¾ in. for supporting the optical arrangements and in which the weight of the revolving apparatus descends.

This column was cast in nine lengths, each terminating with circular flanges to which the floor-plates are bolted. At a height of 2 ft. above each floor there is an opening into this hollow column 26 in. high and 15 in. wide to which wooden doors are fitted. It is used during the day for passing stores up and down, and it likewise contains the waste-water-pipe.

About 20 ft. of the lower part of the tower is filled in with concrete, leaving a well in the middle about 8 ft. in diameter faced with brick-work. There are seven floors, exclusive of the lantern floor or gallery, each 12 ft. in height. The first and second floors are cased with brick-work and serve as oil and store rooms; the five upper floors are lined with sheet iron, No. 16 gauge, disposed in panels, with oak pilasters, cornices, and skirtings.

On the first floor there is a cast-iron curb 10 in. wide and 1



in. thick, on which a cast-iron floor-plate ⅝ in. thick is fixed by bolts ⅝ in. in diameter. The inner edges of this, and of all the other floor-plates in the tower, are bolted between the flanges of the corresponding parts of the hollow column by ⅝-in. bolts, nuts, and washers.

The second floor consists of 10 radiating cast-iron plates ⅝ in. thick, extending from the brick-work to the hollow column; these plates have flanges on their under side and are held together by ⅝-in. bolts at intervals of 6 in. The other floors are similarly constructed, but the outer edges rest on the upper flanges of the shell, being bolted to it by the same bolts which connect the flanges of the plates of the shell. There are five windows in each floor, one in the center of every alternate plate in the circle; these windows are 18 in. square, and are fitted with strong wooden posts opening outward, in which a plate of polished plate glass, 9 × 5 in., is fixed for giving light when the port is closed. There is also a window of the same dimensions in the circular wall for admitting light to the staircase, making 36 windows in all.

The staircase consists of two wrought-iron stringers 1⅝ in. square, the rises and supports being ⅝ in. thick with oak treads 1½ in. thick. To each step there is an iron baluster ⅞ in. in diameter, on the top of which is fitted a wrought-iron hand-rail 1⅝ in. wide and ⅝ in. thick. A wrought-iron ring 5 in. wide and ⅝ in. thick, made in four pieces, is attached to the under side of the eighth floor by screw-bolts ½ in. in diameter, to which the lantern and light-room are bolted. The height from the gallery to the center of the light is 11 ft., and from the center of the light to the top of the vane is 17 ft., making the total height of lighthouse 378 ft. 9 in. above level of high-water. The light can be seen from the deck of a vessel at a distance of 26 or 27 miles. The total cost, including the lighting apparatus, was about $38,000.

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THE Department of Transportation, which is comparatively a new addition to the National Museum, under the charge of the Smithsonian Institute, in Washington, is making good progress in increasing its collection, under the energetic charge of Mr. Watkins. This Department is well worthy of attention, and its value could be largely increased should it receive the attention and support which it deserves from the railroad companies. There is doubtless a large amount of material scattered around the country, which would be of service in such a collection, but which is liable to be lost if not cared for, and any one knowing of the existence of such material, will be doing a public service by calling Mr. Watkins's attention to it.

BRIDGE engineers seem to have devoted themselves lately to the construction and designing of long spans, and projects for big bridges multiply. If they are all carried out, the Hudson, the Mississippi, and others of our great rivers will be crossed at points hitherto considered impracticable, and by spans of a length which not long ago was deemed impossible except with a suspension bridge. This is partly due to the continued improvement in material available for use in bridges, and partly of the successful results which have been attained recently in long-span bridges at various points.

THE agitation which has been begun by several of the local engineering societies in favor of improvement in highway bridges, has very much to recommend it. The methods which have prevailed to a great extent in letting the contracts for such structures are not to be commended, and the decision between different bidders too often depends upon a board of local commissioners, who are entirely ignorant of the first principles of bridge construction, and are apt to be governed by motives not above suspicion. Honest bridge-builders have been discouraged by the impossibility of competing with those who are not above adopting doubtful methods, and the result has been apparent in the construction of many bridges which are anything but a credit to their builders.

There may be some difference of opinion as to the results to be obtained by State inspection, which is proposed as a remedy, but at present it seems to be the only practicable way of getting at this evil, and the agitation in its favor must be considered as a step in the right direction. If it is to be carried out it might be extended to all highway bridges and crossings, including not only the larger and more important ones, but the small structures, which are usually designed and built by some local carpenter, and are not unfrequently examples of poor design and worse workmanship.

THE Illinois Central, which has always been considered one of the safest and most conservative of companies, has suffered, like nearly all Western roads, from the loss of business and reduction in rates resulting from the building of parallel lines and from excessive competition. For the first time in many years its stockholders are obliged to face a reduction in dividends, and the situation is explained in a report just issued by the Company, which is simply a repetition of these facts emphasized by the figures and details given.

MILITARY considerations are not generally taken into account in building a railroad in this country, the only line in America whose location was finally determined by such considerations being the Intercolonial in Canada. We do not, therefore, appreciate how much they have to do with railroad building in European countries, and this fact may explain many things which will appear singular to us in consulting a railroad map of France, Germany, or Austria, for instance. In nearly all European countries the railroad systems are under strict Government regulation, and their lines are laid out and built with special reference to their use in time of war. This necessarily involves the building of some lines which are hardly required for commercial purposes and which cannot be profitable. In Germany and Austria nearly all such lines existing are owned and operated by the Government, but in France there has recently been considerable complaint from the great companies because they have been obliged to bear the burden of building and the cost of maintaining branches which were considered necessary by the War Department, but which are altogether unprofitable commercially. They ask relief from the Government and will probably receive it.

THE City Railroad Company, which proposes to build an elevated railroad in New York, running through the blocks and using public property only at the street crossings, has begun proceedings, by applying to the Courts for the necessary authority to condemn and purchase property, which it needs for its line. It will doubtless meet with much legal opposition and the result is very doubtful. The plan for the road is not generally known, and has, perhaps, been regarded somewhat doubtfully by the public, which has not had an opportunity of becoming acquainted with the details.

THE question of coast defenses, which is now attracting much attention in Congress and elsewhere, is calling out active discussion both in this country and in Europe. For our own protection we are to have, in the near future, at

least two floating batteries and one or more boats armed with the new dynamite gun, all of which will be efficient, but will go a very little way toward the real settlement of the question.

In this connection it may be noted that there is a growing distrust, among those who have studied the subject, in the torpedo systems, in which so much popular confidence has been placed, and especially in the automatic or self-moving torpedo. There has been no opportunity of testing these to any extent in actual service, but such experiments as have been made seem to show that very little reliance can be placed upon them, owing to the difficulty of giving them proper direction and of exploding them at the right moment.

A substitute for the automobile torpedo, or, rather, an enlargement of the idea, is the submarine vessel of which the *Nordenfelt* torpedo boat is the most advanced type. Several of these have been tried abroad with apparent success, and bids have recently been received by our own Navy for a boat of the same class, one of which will probably be accepted. These vessels are necessarily small and their use is attended with considerable risk, but they have, at any rate, the advantage that they can be directed and worked with some degree of certainty.

The dynamite gun is to be made a feature of the land as well as of the sea defenses of our coast, a number having been ordered by the Secretary of War for use in the forts near New York and Boston.

THE sea tests of the gunboat *Yorktown*, the latest addition to the Navy, have been remarkably successful so far as reported, the vessel behaving excellently and showing a higher speed even than the contract called for. On the preliminary test she made 17.2 knots an hour, her engines developing 3,550 H.P. with forced draft, while in a four hours' run at sea, and under unfavorable conditions of wind and tide, she made an average of 15.9 knots an hour, proving herself not only a fast, but a very steady vessel of her size. The *Yorktown* belongs to a class of vessels which will probably be an exceedingly useful one in our Navy, and it is to be hoped that the other ships now under construction will make as good a showing.

THE course of the Navy Department in limiting the size of the guns furnished to the new cruisers now building, and in avoiding the construction of anything like the 100-ton or even 67-ton guns of the English and Italian Navies, is meeting with much commendation from naval engineers abroad, many of whom have been always opposed to the use of these enormous guns. In fact a reaction against them seems to be springing up even in England, where some elaborate arguments have recently been presented against arming a vessel with one or two huge guns, and where the greater usefulness of the light vessels carrying a larger number of smaller guns is finding many advocates.

THE second cast-steel gun made for the Navy Department has met with better success than the first, having passed through the preliminary tests successfully ; however, it has still to undergo what is known as the endurance test. This gun was made of open-hearth steel, the first one which failed having been of Bessemer steel, but it is not yet by any means certain whether the failure of the Bessemer gun was due to the material or to defects of the casting. The tests of the second gun are shortly to be resumed and will be exhaustive in their nature.

This is a question of considerable importance, not only on account of the lower cost of cast guns, but also on account of the rapidity with which they can be made, which would be a matter of very great importance under certain contingencies. It is not impossible that the final result may be a compromise between the cast and the built-up guns, the nature of which may be readily suggested.

HIGHWAY grade crossings are the subject of an elaborate report made to the Massachusetts Legislature, by a special commission appointed last year. This report states that there are in the State 2,280 grade crossings, while there are only 748 crossings at which the track and road grades are separated either by an overhead or an under crossing. Of the grade crossings not less than 1,393 are unprotected by gates, flags, or other signals. In the 10 years ending with December last, 75 grade crossings were abolished, but during the same period 155 new ones were made, so that the number has been actually increased. How much delay and how much risk of accident is caused by this great number of level crossings in a populous State like Massachusetts cannot easily be imagined. The Commission recommends, as the first step toward a reform, an absolute prohibition of any new crossings of railroads and highways at grade. As to the abolition of the existing ones, it considers that a very difficult question is presented, on account of the great expense required, while at the same time it is to be considered that the cost will grow with every year of postponement. A general estimate of the expense of doing away with these crossings, were the work to be done at once, puts the total cost at $48,131,000, an amount which, it will be readily seen, neither the railroads nor the towns are able to meet now.

The plan recommended is a gradual separation of the grades, say 5 per cent. of the number to be finished in each year, and it is further recommended that the cost be divided between the railroads and the towns. It is admitted, however, that it would be entirely impossible to pass any general law regulating the division of cost, and that each case must be judged on its merits by some special tribunal to be provided for by the Legislature.

COMPOUND LOCOMOTIVES.

THE arrival in this country of the Webb compound locomotive, which the Pennsylvania Railroad Company ordered about a year ago, will naturally lead railroad engineers to consider the merits of the compound system, which has now been thoroughly tested on English and Continental railroads. It has been pointed out by some one that an unwillingness to profit by the experience of foreigners is a natural defect of the American character. This fault the officers of the Pennsylvania Railroad have avoided, in the present instance, at least. The advantages of the compound system, as applied to locomotives, have been definitely promulgated by thoroughly competent engineers like Mr. Webb, of the London & Northwestern Railway, Mr. Worsdell, of the Northeastern Railway, Mr. Von Borries and Mr. Mallet, on the Continent, who have all had ample experience in the use of such engines to enable them to form correct opinions regarding their advantages. The officers of the Pennsylvania Railroad, therefore, assumed the position that, if there was any merit in the compound system,

engineers of the ability of those named, who had given much time and thought to its introduction, and who have had more experience in its use than any other persons, would necessarily know more about it than any one else could. The Pennsylvanians therefore determined to test the system, and in doing so to avail themselves of the experience of those who had gone before them and avoid their mistakes and profit by their success. A locomotive was therefore ordered to be built in England under Mr. Webb's directions, with few or no restrictions, leaving the responsibility for the success or failure of the engine entirely with him. A mechanic has come over with the machine, to erect it, and a locomotive runner and fireman have been sent to run it. In other words, the Pennsylvania Railroad officers have said to Mr. Webb, "We want to profit by your experience; send us one of your engines and show us what it can do"; which seems a very much wiser course to pursue than the pretentious policy—altogether too common—of assuming that a person without investigation or study or experience knows more of a subject than intelligent people do who have given years of time and thought to learning all that can be known about it.

It would not be necessary to go very far to find illustrations of this error. Some years ago, for example, the traffic of this country demanded a more perfect system of signals on our railroads. Under those circumstances it might be supposed that, if anywhere on the face of the globe, a similar condition of things existed, and years of time, study, and experience had been devoted to supplying the demand, that railroad managers and engineers would eagerly avail themselves of the results of that study and experience. Instead of doing this there was a period when it seemed as though every ingenious railroad engineer in the country was devoting himself to the evolution, out of his inner consciousness—without any knowledge or experience of the subject—of a system of railroad signals. When managers or engineers were without ingenuity themselves, they called in the aid of the cranks, and the yards of the railroads of the land for a time fairly blossomed with signals of every conceivable form and shape. In the absence of any other source of illumination a pack of cards seemed to be the first source of inspiration, and hearts and diamonds and the ace of spades did duty as signals on various roads. In New England huge banjo-shaped signals were erected on several lines, until it seemed as though they were devoted to advertising some company of negro minstrels. If the signal evolutionists had simply consulted a little book, "Railroad Appliances," published about this time, they would have found the following statement: "About 1841 the signal known as the Semaphore signal was introduced by Mr. C. H. Gregory, and has been found so superior to all other types, that it is rapidly superseding all the other signals, and before long it will probably be the only daylight fixed signal used in this country" (England). The prophetic part of this seems likely to apply here as well as to Great Britain, as the diamonds, hearts, spades, and banjos are falling like leaves in autumn, and the Semaphore signal is extending its warning arm from one end of the land to the other. The same process was gone through with reference to systems of interlocking and block signals. A great variety of these were tried and much money wasted, while at the same time entirely successful and practical systems were in use in Europe and were adopted later here, after a good many imperfect plans had failed. Since then American genius has been exercised on the European systems, and they have been improved and adapted to our wants and requirements. The moral of this is that when any persons know more of a subject than we do, it is wisdom to profit by their knowledge. Of course if they do not know more than we, there is nothing to be gained from them. No American would go to Europe for information about building grain elevators, threshing-machines, saw-mills, or sinking oil and gas wells, but it is, perhaps, not disloyal to admit that there are some subjects about which they have had more experience than we have; and that compound locomotives is one of them.

After the Pennsylvania-Webb engine has shown what it can do, there will be a chance for American locomotive engineers to improve on it, and it will be very surprising if it does not go through an evolutionary process which will adapt it much better to its new environment on this side of the Atlantic. But even if the Webb engine does all that is claimed for it, the adoption of the compound system may still be an open question. In a paper recently read before the Institute of Civil Engineers it is claimed that it effects a saving of about 15 per cent. in the consumption of fuel. On the Pennsylvania Railroad, including the New Jersey and the Philadelphia & Erie roads, the fuel consumed by locomotives costs annually nearly $3,000,000; 15 per cent. on this would be $450,000. It would seem as though considerable outlay could be profitably made to effect such a saving. In this, as in many other cases, it is not safe to come to conclusions quickly. There can be no doubt that by the use of feed-water heaters a saving of from 10 to 12 per cent. of the fuel can be effected. This can be proved theoretically and has been demonstrated practically. Nevertheless, feed-water heaters have been tried times without number, and have always been abandoned, unless their use is continued under the stimulus of the inventor's "influence." Now, what is the reason for this? It is due, apparently, to the fact that the use and maintenance of feed-water heaters is attended with some extra care and expense; but perhaps more because feed-water heaters lessen the number of days and miles of service which locomotives will render annually. There are periods on nearly all roads, when the service of every locomotive which the company owns is urgently needed, and when the loss of such service means a serious pecuniary loss. Every appliance or additional part applied to a locomotive increases the liability of its being disabled, and because feed-water heaters are liable to fail at such periods seems to be—more than any other cause—the reason why their use is abandoned. It seems not to be as generally recognized as it should be, that the loss of the service of a locomotive, when it is most needed, is a very serious and costly matter.

The writer of the paper already referred to says that the adoption of high pressure steam is attended with the following drawbacks: "The boiler and all steam joints must be more carefully made. Only the better kind of lubricants are admissible, such as are not decomposed at the higher temperatures of the steam. The gland packings must be constructed to withstand heat. The high-pressure cylinder is liable to corrosion. The large low-pressure cylinders are more cumbersome and have more cooling surface than small compact cylinders. A large quantity of water of condensation might be observed in the chimney, thrown from the blast pipe of the large low-pressure cylinder, making safety valves on this cylinder essential. The momentum of a piston, 26 in. or 30 in. in diameter,

together with that of the other reciprocating parts of the large engine, causes severe strains, which must be provided for." To these objections must be added the additional cost of compound engines, and the hypothetical one whether they are more troublesome to run and maintain than simple engines.

The cost of fuel per locomotive per year on the Pennsylvania system may be taken in round numbers at $2,000; 15 per cent. of this—the saving claimed for the compound system—is $300, a sum which it would be very easy to absorb in the maintenance of additional or more complex parts, or by the loss of service of the engine.

NEW PUBLICATIONS.

PREPARING FOR INDICATION: *Practical Hints; the Result of Twenty-three Years' Experience with the Steam-Engine Indicator*: by Robert Grimshaw, M.E. New York; Practical Publishing Company.

This is a small book containing practical directions for applying an indicator to different classes of engines. It is well illustrated, and will be of value to those without experience who want information with reference to the use of this important instrument. The directions relate chiefly to the methods of attaching indicators to cylinders, the arrangement of pipes, levers, etc., details which are sometimes puzzling to new beginners.

COMBUSTION IN LOCOMOTIVE FIRE-BOXES: BY ANGUS SINCLAIR. New York; *National Car & Locomotive Builder.*

This is a small pamphlet of 21 pages, which contains an elementary explanation of the theory of combustion, with practical directions for firing a locomotive. It is written in a very simple and lucid style, admirably suited to the purpose for which it is intended, which is "to supply knowledge-seeking enginemen with information relating to the fundamental principles underlying the art of firing."

BULLETINS OF THE UNITED STATES GEOLOGICAL SURVEY: NUMBERS 40-47 INCLUSIVE. Washington; Government Printing Office.

The present issue continues the admirable series of monographs issued from time to time by the United States Geological Survey on various topics connected with its work. The subjects of the present numbers are:

No. 40: Changes in River Courses in Washington Territory due to Glaciation.

No. 41: The Fossil Faunas of the Upper Devonian—the Genesee Section, New York.

No. 42: Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1885-86.

No. 43: The Tertiary and Cretaceous Strata of the Tuscaloosa, Tombigbee and Alabama Rivers.

No. 44: Bibliography of North American Geology for 1886.

No. 45: Present condition of Knowledge of the Geology of Texas.

No. 46: Nature and origin of Deposits of Phosphate of Lime.

No. 47: Analyses of Waters of the Yellowstone Park, with an Account of the Methods of Analysis Employed.

It is impossible to review these monographs in detail, and it can only be said in a general way that the work which the Survey is doing is much increased in value to the scientific world by the issue, from time to time, of these notes of progress made and results obtained.

PLATE GIRDER CONSTRUCTION: BY ISAMI HIROI. New York; published by the D. Van Nostrand Company (Van Nostrand's Science Series, No. 95; price, 50 cents).

The use of plate girders is becoming more general every day upon our railroads, for highway crossing bridges and for railroad bridges of less than 60 or 75-ft. span. When properly designed, nothing can be more economical or secure; the majority are, however, faultily designed in regard to the most economical use of material, and some few in regard to actual safety.

As the Author states in the preface, this little book "presents in as simple a manner as possible a rational mode of designing plate girders." Without going exhaustively into the theory of stresses, it explains concisely the nature of web stresses, the graphical method of finding the maximum shear under any load, and rules for the proportioning of the web with the design and spacing of the stiffeners. Then follow the flange-stresses, and the proportioning of the flanges and plates, with clear and concise instructions upon the spacing of rivets and the making of all necessary splices and connections, together with rules for the lateral bracing.

There is just enough theory introduced to enable one to understand the course of reasoning followed in formulating the rules given.

Owing to the lack of books on this subject that are within the general reach of draftsmen and engineers, this work ought to find ready acceptance at their hands and prove a useful book for students of engineering.

REISE S. M. SCHIFFES "ALBATROSS" NACH SÜD-AMERIKA, DEM CAPLANDE UND WEST-AFRIKA, IN DEN JAHREN 1885-86. EDITED BY CAPTAIN JEROLIM VON BENKO. Pola, Austria; issued under authority of the Ministry of War.

This is a very full account of a cruise made by the Austrian war-ship *Albatross* in the South Atlantic, and is one of a series of similar accounts issued under the charge of the Hydrographic Office of the Austrian Navy. It is not a mere journal or log of the ship's voyage, but contains much valuable information with regard to the countries visited, their government, commerce, etc., and facts of service to navigators.

It is accompanied by a large map showing the course followed by the *Albatross* on her cruise and the various ports at which she touched.

CHALLEN'S ENGINEERS' LOG-BOOK OF THE DAILY RUNS OF AN ENGINE FOR ONE YEAR. New York; published by Howard Challen, 140 Nassau Street (price, 75 cents and $1).

This very convenient and almost indispensable companion for a stationary engineer is a book of convenient size for the pocket, with a page for each week in the year, a line being given for each day. It is ruled, with printed headings, columns being given for average pressure;

hours run; revolutions; vacuum; piston speed; indicated H.P.; initial pressure; terminal pressure; temperature of hot well and heater; water used per H.P.; fuel burned; ashes; oil and waste used, and a blank column for any additional note which experience may suggest. A blank space is also left to note defects observed, repairs needed, and any other necessary matters.

With this book it is the work of only a few minutes each day for an engineer to keep a full record of all essential points relating to the working of his engine. How useful this is all careful engineers know, and no small part of its helpfulness lies in the ability to refer readily to the past record and compare the running of the engine at different periods and under different conditions.

DEVELOPMENT OF TRANSPORTATION SYSTEMS IN THE UNITED STATES: *Comprising a Comprehensive Description of the Leading Features of Advancement from the Colonial Era to the Present Time, in Water Channels, Roads, Turnpikes, Canals, Railways, Vessels, Vehicles, Cars and Locomotives; the Cost of Transportation at Various Periods and Places, by the Different Methods; the Financial, Engineering, Mechanical, Governmental and Popular Questions that have Arisen; and Notable Incidents in Railway History, Construction and Operation; with Illustrations of Hundreds of Typical Objects:* by J. L. Ringwalt, Editor of the *Railway World*. Philadelphia; published by the Author.

This long descriptive title, while it is a little inconvenient on account of its length, has the advantage of giving information of the general character of the book, which is a good-sized quarto volume of 398 pages, liberally illustrated with engravings—such as they are. As its title indicates, it has a historical character, but it can hardly be called a history, as apparently no exhaustive investigation or no attempt even has been made to write a complete history of any branch of railroad development. That task still remains for some patient plodder who has at least the one characteristic of genius—an infinite capacity for taking trouble.

The book before us consists of a mass of interesting material, which the author has collected together during some years of editorial work on the paper with which he is connected. To a railroad man it is as interesting as a novel—much more so than some novels. It has a sort of flavor that reminds the reader of Cooper's stories, and one reads on and on continually interested in the variety of subjects to which it relates.

It is divided into three general heads—Before Railways; Railway Infancy; Railway Youth, and Railway Manhood. A sort of gossipy sketch of the different methods of transportation which have been used on land, water, and rail is given with illustrations of beasts, boats, vehicles, and structures in various ways related to transportation. With so interesting a book before us it is hard to drive away the smile of satisfaction and assume a frown of condemnation. But how did the Author succeed in having such wretched drawings and engravings made for his book? In this day of art culture and improved processes of engraving, it would be difficult to know where to go to have equally bad illustrations made. If the Author made his own drawings, the knowledge of it will lead the reader to wonder how he could be so good an editor and so poor an artist, and to feel sure that in the latter calling he has missed his vocation. The book would be increased immensely in value if the illustrations were what they should be, and also if the source from which they were obtained was given. In such illustrations the investigator finds that there is often great lack of authenticity. Thus the engraving of Oliver Evans's *Orukter Amphibolis*, opposite page 24, differs materially from that opposite page 160; and that of the *John Bull* on the same page looks as though it had an attack of dropsy.

It is always an ungracious task to point out errors in a work of this kind, because a reviewer with any experience as a writer has a vivid consciousness of the many errors which the Author did not fall into, and the pains he must have taken to avoid them. For old acquaintance' sake, attention should be called to the fact that the name of Mr. Bollman, the inventor of the bridge which bears his name, was not "August," as given opposite page 208, but Wendel.

The book will interest nearly all who are concerned directly or indirectly with railroads, but it is to be hoped that in a future edition the author and publisher may see his way to giving new and better illustrations.

EXHIBIT OF THE NAVY DEPARTMENT AT THE CENTENNIAL EXPOSITION OF THE OHIO VALLEY AND CENTRAL STATES, CINCINNATI, OHIO, JULY 4–OCTOBER 27, 1888. Issued under authority of the Navy Department.

This catalogue, prepared by Lieutenant Richard Rush, the representative of the Navy Department at the Exposition, is something more than a mere catalogue of the articles shown, and gives an excellent and connected account of the exhibit, the object of which was to give, first, a representation of the work now in progress in the reconstruction of the Navy, both in ships and armament; and, second, a general view of the extent and importance of the scientific work accomplished by the Navy in time of peace.

The exhibit included contributions from the Bureau of Construction and Repair, the Bureau of Ordnance, the Bureau of Navigation, the Naval Observatory, and the Naval Academy.

OUTLINE OF PLANS (WITH ILLUSTRATIONS) FOR FURNISHING AN ABUNDANT SUPPLY OF WATER TO THE CITY OF NEW YORK FROM A SOURCE INDEPENDENT OF THE CROTON WATER-SHED, DELIVERED INTO THE LOWER PART OF THE CITY UNDER PRESSURE SUFFICIENT FOR DOMESTIC, SANITARY, COMMERCIAL AND MANUFACTURING PURPOSES AND FOR THE EXTINGUISHMENT OF FIRES: WITH LEGAL, ENGINEERING AND OTHER PAPERS. New York; John R. Bartlett and Associates.

This book is an elaborate presentation of the advantages claimed for the plan of drawing an additional water-supply for New York City from the water-shed of the Upper Passaic in New Jersey, instead of procuring the supply from the Croton River by increasing the storage capacity in the basin of that river. It contains a number of addresses made in favor of the plan; legal opinions as to the right to use New Jersey waters; estimates of cost and a full statement of the urgent necessity of an additional supply. There is also a report from the Consulting Engineers who examined the project—Messrs. Clemens Herschel, Alphonse Fteley, and Captain T. W. Symons.

The illustrations include maps of the Croton and the Passaic water-sheds; a profile of the proposed pipe-line for carrying the water to and under the Hudson River; photographic views of a number of points in that section of New Jersey from which it is proposed to draw the new supply, and sectional views of the Hudson River Tunnel.

The plan has certainly been well presented by its advocates, for it would not be easy to find anywhere so elaborate a statement of the merits of any engineering project. Perhaps more space might have been given to its engineering side, and less to the legal and economic aspects of the question; but probably the book is intended to reach those who will control the decision of the question and the appropriation of the money rather than the engineers who will have to plan the details and supervise the execution of the work.

THE WOODWARD ELECTRICAL COMPANY, MANUFACTURERS OF THE DETROIT STORAGE BATTERY: CATALOGUE AND DESCRIPTION. Detroit, Mich.; issued by the Company.

There is, we believe, a very active controversy now in progress among electricians as to the true value and place of the storage battery. Without pretending to judge or to decide the question, there can be no doubt that the storage battery will have a place of its own, as a convenient method of applying electrical power in many places where the dynamo cannot be used.

This pamphlet gives an account of the construction and management of a new form of storage battery, with some considerations on the general question of the use of such batteries and the purposes for which they will be found convenient. There are also some elementary Electrical Data, by Lieutenant F. B. Badt, which will be found convenient for reference by the general reader.

VICK'S FLORAL GUIDE FOR 1889. Rochester, N. Y.; published by James Vick, Seedsman.

The practise of beautifying the grounds adjoining railroad stations is growing very general on the lines in the older-settled States, and has much to commend it. Station agents and others who need advice can hardly find a better guide than this work, which is not by any means a mere catalogue of seeds, but contains much useful information for the gardener, whether professional or amateur.

ABOUT BOOKS AND PERIODICALS.

THE Railroad Mail Service is described in the March number of SCRIBNER'S MAGAZINE by Thomas L. James, Postmaster-General in Garfield's Cabinet. A graphic account of the evolution of mail-carrying in this country, from the days of the colonial carrier to the modern fast mail train, is given.

Among the new books in preparation by John Wiley & Sons are included Professor Thurston's *Manual of the Steam Engine*, which is intended as a companion to his *Manual of Steam Boilers*. Other books in the same department are Professor Peabody's *Notes on Thermo-Dynamics and Steam Engine Experiments*; *Kinematics, or Practical Mechanism*, a treatise on the transmission and modification of motion and the construction of mechanical movement, by Professor Charles W. MacCord, and *Steam Engine Design*, by Professor J. M. Witham.

Those for the use of civil engineers are a *Treatise on Masonry Construction*, by Ira O. Baker; a *Treatise on Hydraulics*, designed as a text-book for technical schools, by Professor Mansfield Merriman, and Ganguillet and Kutter's *Flow of Water in Rivers and Other Channels*, translated, revised, and extended by Rudolph Hering and J. C. Trautwine, Jr.

The first number of the JOURNAL of the American Society of Naval Engineers, for February, 1889, contains articles on Trials of a Steam Barge, by Chief Engineer B. F. Isherwood; Tests of the High Service Pumping Engines at Washington, by Past Assistant Engineer G. W. Baird; Problems in Propulsion, by Assistant Engineer W. D. Weaver; Coals of the Pacific Coast, by Past Assistant Engineer C. R. Roelker; Quadruple Expansion Engines, by Assistant Engineer F. C. Bieg; also several other articles of interest, and a number of short notes on Steam Trials, New Ships and other current naval matters. The new Society, we understand, has already a large membership, and has, we hope, a prosperous and useful career before it.

An article which is worth careful reading is that on Slow Burning Construction, by Edward Atkinson, in the CENTURY MAGAZINE for February. Mr. Atkinson is an authority on more than one point, and his conclusions on a matter which he has studied attentively, are of interest to manufacturers, railroad companies, and architects who have occasion to build, design, or use large structures for industrial purposes. Economy and a regard for human life alike require the adoption of systems of building which shall avert danger from fire; and that these considerations should be so generally disregarded in our factory buildings is not creditable.

An article of interest to engineers in the POPULAR SCIENCE MONTHLY for February, is that by Professor G. A. Daubree, on Underground Waters in Rock Transformations. It is a continuation of several others on points relating to Underground Waters by the same Author.

In the same number Political Control of Railroads is discussed by Appleton Morgan, from the standpoint of an extreme opponent of any form of control whatever. Mr. Morgan argues plausibly, though many readers will hardly be disposed to admit all the premises which he assumes, and it would not be difficult to find flaws in his reasoning. Nevertheless, the article should be read as a good statement of one side of a much-disputed question.

Dakota, more than any Western State—except, perhaps, Kansas—has made by the railroads, and the article on that Territory in HARPER'S MAGAZINE for February, emphasizes this fact. The article is descriptive—almost colloquial—rather than statistical, but gives figures enough to support its facts and to give the reader a fair idea of the present standing and condition of what is likely to be the next new State, or, more probably, two States.

BOOKS RECEIVED.

ON THE USE OF HEAVIER RAILS FOR SAFETY AND ECONOMY IN RAILWAY TRAFFIC: BY C. P. SANDBERG, C.E. London, England; published by the Institution of Civil Engineers. This is a paper read before the Institution by Mr. Sandberg, who is well known as a high authority on the subject.

AN INVESTIGATION OF THE CONSTRUCTION OF THE VARIOUS KINDS OF CUPOLAS THAT HAVE BEEN USED FOR THE MELTING

of Pig Iron: by M. A. Gouvy, Jr.; Translated by W. F. Durfee, Engineer. Philadelphia; reprinted from the *Journal* of the Franklin Institute.

Annual Report and Statements of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce and Navigation, Immigration, and Tonnage of the United States for the Fiscal Year Ending June 30, 1888: William F. Switzler, Chief of Bureau. Washington; Government Printing Office.

Eleventh Annual Report of the Board of Railroad Commissioners of the State of Iowa, for the Year Ending June 30, 1888: Peter A. Dey, Spencer Smith, and Frank T. Campbell, Commissioners. Des Moines, Iowa; State Printers.

The Journal of the Iron & Steel Institute: 1888. London; published for the Institute by E. & F. N. Spon.

Professional Papers of the Corps of Royal Engineers: Edited by Major Francis J. Day, R.E. Volume XIII, 1887. Chatham, England; published by the Royal Engineers' Institute.

Report of the Proceedings of the Twenty-Second Annual Convention of the Master Car-Builders' Association, held at Alexandria Bay, N. Y., June 12, 13, and 14, 1888. New York; issued by the Association.

Condensers for Steam Engines: by J. H. Kinealy, St. Louis; reprinted from the *Journal* of the Association of Engineering Societies. This is a paper read by Mr. Kinealy before the Engineers' Club of St. Louis at its meeting in December last.

Universal Milling Machines: Catalogue. Philadelphia; issued by Pedrick & Ayer, 1625 Hamilton Street.

The Harris-Corliss Engine as Built by the W. A. Harris Steam-Engine Company: Catalogue and Description. Providence, R. I.; issued by the W. A. Harris Steam-Engine Company.

Some Recent Boiler Explosions, and Short Talks to Steam Users. Hartford, Conn.; issued by the Hartford Steam-Boiler Inspection & Insurance Company.

How to Keep Steam Boilers Free from Incrustation: Tri-Sodium Phosphate Water Purifier. Philadelphia; issued by the Keystone Chemical Company.

The Comparative Danger to Life of the Alternating and Continuous Electrical Currents: by Harold P. Brown, Electrical Engineer. New York; published by the Author.

FRENCH AND AMERICAN PRACTICE WITH EMERY WHEELS.

To the Editor of the Railroad and Engineering Journal:

THE carefully illustrated article in the February number of the JOURNAL, translated from the *Revue Generale des Chemins de Fer*, would lead a superficial reader to imagine that French science had been brought to bear upon the emery wheel in a way that contrasted strongly with loose methods elsewhere. French practice and principle, if the above article correctly represents them, are strikingly different from the best practice and principle in the United States.

The French journal practically takes the ground that the safety of an emery wheel is an entirely unknown quantity, and that mechanical devices are needed as a supplement. The best American principle is embodied in the following quotation which has been widely circulated for years: "We caution the public against any and all mechanical devices to prevent wheels from bursting. Any wheel which will not stand a surface speed of 5,500 ft. per minute, in actual use, and without mechanical reinforcements, is unfit to run. We also caution the public against the use of stone-center, iron-center, and open-center wheels."

The mechanical devices which have been tried in the hope of making emery wheels safer have generally resulted in making them more unsafe. Wheels have been surrounded with cast-iron and other metal shields, which have generally broken at some weak point. Extra large flanges have been used, and still the bursting wheel would escape from their clutches. In one case, not content with extra large flanges, the users bored from four to six holes through the wheel and fastened the flanges by iron bolts running through the wheel. It seems needless to say that some of the bolts were screwed much tighter than others, and that the tension was so unequal that the wheel burst almost at once, killing the workman.

The whole tendency of mechanical reinforcements is to create a false idea of safety, and to prevent users from finding out *what* wheels are safe or unsafe and *why* they are safe or unsafe.

Wheels may be unsafe because the matrix in which the emery is embedded, or the cement which binds it together, have too little cohesion. Such wheels are often described as rotten. A wheel of this kind, bursting, would not be likely to exhibit *radial* cracks or breaks (as in the French case), but would throw pieces off irregularly. We have seen many such wheels in which all outside of the flange flew off, while that inside was held fast. Wheels may be unsafe because of unequal tension. Wheels made by the process of vitrifaction, or by artificial stone processes, or by any process in which the hardening, setting, or chemical change proceeds from the outside to the center, are likely to be subject to great and unknown inequality of tension. If such wheels do not crack from this tension before use, yet the repeated heatings and coolings due to use cause expansion and contraction whose final effect may be to start a break.

Wheels may be unsafe because of imperfect chemical combination and continued disintegrating chemical action. A wheel was once patented whose strongest claim rested upon the use of a material for its mechanical effect only, while the material employed possessed chemical properties unthought of by the user, and worked the ruin of the wheel.

Wheels may be unsafe because they are too good conductors of heat. We have seen two wheels of different makes tested, in which one remained uninjured and comparatively cool after 45 minutes' hard work, while the other burst after four minutes' work of some severity, and was so hot that it could not be handled. Yet both of these wheels had stood successfully the high speed test. The superficial observer would on this account have rated one as safe as the other, while the experienced user would have predicted that the one which was the poorest conductor was the safest. Those makers who advertise that their wheels consist entirely of cutting properties—that is, that they are wholly mineral—advertise their danger by that claim.

The safe wheel, then, must be made with a cement or matrix of great cohesive power—it must be a poor conductor of heat, it must contain no permanently active chemical ingredients, and it must not be made by any baking, drying, vitrifying, or setting process which acts from the outside to the center, subjecting the mass to, and often leaving it under unequal tension.

Having such a wheel as this, why then should it break? Such wheels might break from purely mechanical defects. For instance, some wheels are molded under high heats and with heavy hydraulic pressure. The mass of which the wheel is composed is forced by such pressure around and against the central steel pin whose office it is to mold the mandrel hole. If this wheel is removed from the mold at a moderate heat, or in an hour or two of time after it is finished, it would probably be perfect. But if allowed to remain too long in the mold and get too cold the contraction or shrinkage of a large wheel upon a pin only 1¼ in. in diameter is enough to start a crack in the wheel. Such crack would start at the mandrel hole, would not be perceptible to a careless observer, and could only be traced an inch or two in the strongest light. In some processes

the wheels have to be forced out of the molds by hydraulic pressure, and the pins pushed through the wheels in some way. Now, the emery wears the pins rapidly, and sometimes these pins, owing to such wear, are not of uniform diameter, and being forced through split the wheels just as wedges would.

To sum up this feature let us say that in the handling of the wheel after it has been molded, there are several chances for the most perfect wheels to receive vital but almost imperceptible injury.

Now, the best American practice is to submit *every* wheel to a high speed test. A testing machine is so mounted in a bomb-proof that the machine can be set in motion and stopped by a man outside, and the wheel run under such conditions that no injury can result. Every wheel is run at a surface speed of from two to three miles a minute, though the standard working speed is only one mile a minute. At these speeds wheels which have unseen cracks burst; and by this simple method of destroying in his own factory all imperfect wheels, the American maker —that is, the maker of first-class wheels—succeeds in sending out wheels which may practically be called safe and perfect. If the *Revue Generale des Chemins de Fer* states the French practice correctly, it is the exact opposite of the American; for that journal says that, "Generally, in order to avoid the injury which might be done at too great a speed, the stone is run on its trial only at the highest speed which is to be used in service."

According to the best American practice the method to obtain a safe wheel is to choose one of such a make as is free from certain obvious defects, and which has been subjected to such high speed tests as would destroy all wheels having unseen weaknesses and injuries.

Having thus procured a safe wheel, the question still remains whether such a wheel is likely to break, and, if so, why? We answer that the most perfect wheel is likely to be broken under improper conditions of use. Some such improper conditions are shown in the very devices illustrated by the French journal as a means of obtaining safety. Note, in the first place, that the wheel is an "*open-center*" wheel, and that "open-center" wheels were denounced in the American caution quoted in the beginning of this article. Open-center wheels necessitate either the filling up of the center by the user or the use of flanges similar to those shown in the French illustration. Flanges like these, adapted to the use of open-center wheels, and having the inwardly projecting shoulder on which to center the wheel, were originally patented in America in 1870. At that time there was a general impression that the price of emery wheels was extortionate, and a very erroneous idea that the material of a wheel was more costly than the labor used in making it. In order to cut prices and also to secure the sale of larger wheels, certain makers put upon the market at reduced prices wheels having open centers, stone or composition centers, and molded upon cast iron hubs. Seeing the danger of all such devices, the patentees of the flanges very speedily withdrew them from the market, discountenanced all devices of the kind, and steadily advocated the use of wheels with holes adapted to the diameter of the mandrel or shaft on which it revolves.

Two dangers are inseparably connected with the use of the flanges shown in the French illustration. The first is, that if the flanges are screwed together very hard, as is certain to be the case, they will be sprung, or forced in toward the center, and the inwardly projecting shoulders will be thrown out, their pressure being so exerted as to wedge the wheel apart and disrupt it. The second danger is that if the inwardly projecting circular rims or shoulders are of such diameter as to nicely fit the hole in the wheel, then the expansion of the flange in case of a hot bearing would be likely to burst the wheel. If the hole in the wheel is molded with great mechanical nicety, the tendency would be to fit the inwardly projecting rim to the hole in order that the rim might be used to center the wheel. In this case there would be almost perfect circular contact. On the other hand, if the hole was imperfectly molded or the rim imperfectly turned, there would probably be actual contact between wheel and rim at several opposing points. Now the wheel shown in French diagrams would weigh about 1,500 lbs., and the hole in it is about 12 in. in diameter. If the continued revolution of a wheel of this weight should cause the bearing to heat, that heat would be communicated to the flanges, and the irresistible expansion of 12 in. of cast iron inside of the wheel would tear it apart. As iron expands about 0.0012 in. in being raised from 32° to 212° F., this would make an expansion (for this range of temperature) of about 0.0144 in. for a 12-in. rim.

Thus far all that is done by the French system tends to create the very danger which it is supposed to prevent. But one feature remains—the "bi-conical" shape of wheel. This idea, like that of the flanges, is a very old one, but has not been adopted by the best makers in America, because it is considered as opposed to the best practice and to the principle laid down in caution already quoted. The French article tells of one case only where a wheel broke, with radial lines, and where the flanges held the pieces so they did not fly out, and suggests, very wisely, that it would be better to make the plates or flanges thicker and the conical form more pronounced. "They would then resist still more the radial force of the fragments of the stone, which was produced on the trial mentioned above, and which, if it had been more pronounced, would have caused the fragments to strike against the frame and to produce additional breakages which might have resulted in serious accidents."

Now, accidents are just what would happen if this bi-conical shape was trusted to; for, if the speed was too great or the wheel too weak, it would break the flanges, or tear out from between them, or else what was outside of the flanges would fly off.

According to the best American practice the only office of a flange *is to keep the wheel from turning on its mandrel.* The flange should have enough surface contact and be screwed tight enough to make the wheel revolve *with* (not *on*) the mandrel. The next, and a most important point, of the best American practice, is to have the hole in a wheel so accurately molded and *of such greater diameter* than the mandrel on which it is to run, that the greatest possible expansion of the mandrel will not create any internal or wedging pressure upon the wheel.

In common practice buyers ask for a wheel with a 1-in. hole, when they want a wheel to go on a 1-in. mandrel. The intelligent maker gives a wheel with a hole so much larger than 1 in. that the expansion of the mandrel cannot burst his wheel. The buyer uses the hole to center his wheel by, and of necessity does not get it centered, but runs it with one part higher than the other in such a way that only part of the wheel touches the metal being ground. The correct practice is to hang the wheel on its mandrel, screw up the flanges *slightly*, then turn, chalk and center the wheel as carefully as if it was a piece of work being put in the lathe, and then give the flanges their final tightening.

Briefly, the best American practice is to choose a wheel whose composition is such as to make it free from the defects already pointed out; to buy only of makers of established reputation and long experience; and to insist that every wheel should be submitted to the high-speed test before delivery. Such a wheel should have a hole of diameter suited to a steel mandrel of a strength adapted to the weight of the wheel. In other words, the hole should be *no larger than necessary*, but should have due allowance for possible expansion of the mandrel. Wheels should be mounted on heavy substantial machines, set on and fastened to stone or concrete foundations—the latter clause applying only to heavy wheels.

The safety lies in buying wheels of safe make after they have been submitted to such rigid tests that all poor ones are destroyed, and then mounting those wheels in the *simplest* manner.

Unfortunately, foreign buyers are loath to pay the higher prices which such wheels naturally cost, and too often take the terrible risk of buying cheap wheels in the hope that good luck or some new-fangled safety device will protect them from accident.

Of course *misuse* may cause accident even with the best of wheels, but misuse is not the subject of this article.

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HYDRAULIC CANAL LIFT.

(From *Le Genie Civil.*)

THE Canal of the Center in Belgium is so called from the coal basin, which it was built to serve; it unites the canal from Charleroi to Brussels with that from Mons to Condé, forming a new junction between the basins of the Meuse and the Escaut. It has been built to avoid the roundabout route heretofore followed by the boats which carry this coal and to furnish a new line for coal intended for Brussels and Antwerp.

The principal difficulties encountered in the construction of this very useful work resulted from the great difference of level which it was necessary to overcome, and which amounted altogether to 89.547 meters (294 ft.). The first part of the canal, about 7 kilometers in length, has a rapid fall, running through the valley of the little river Thiriau. The second section, 13 kilometers in length, has a much more gradual fall.

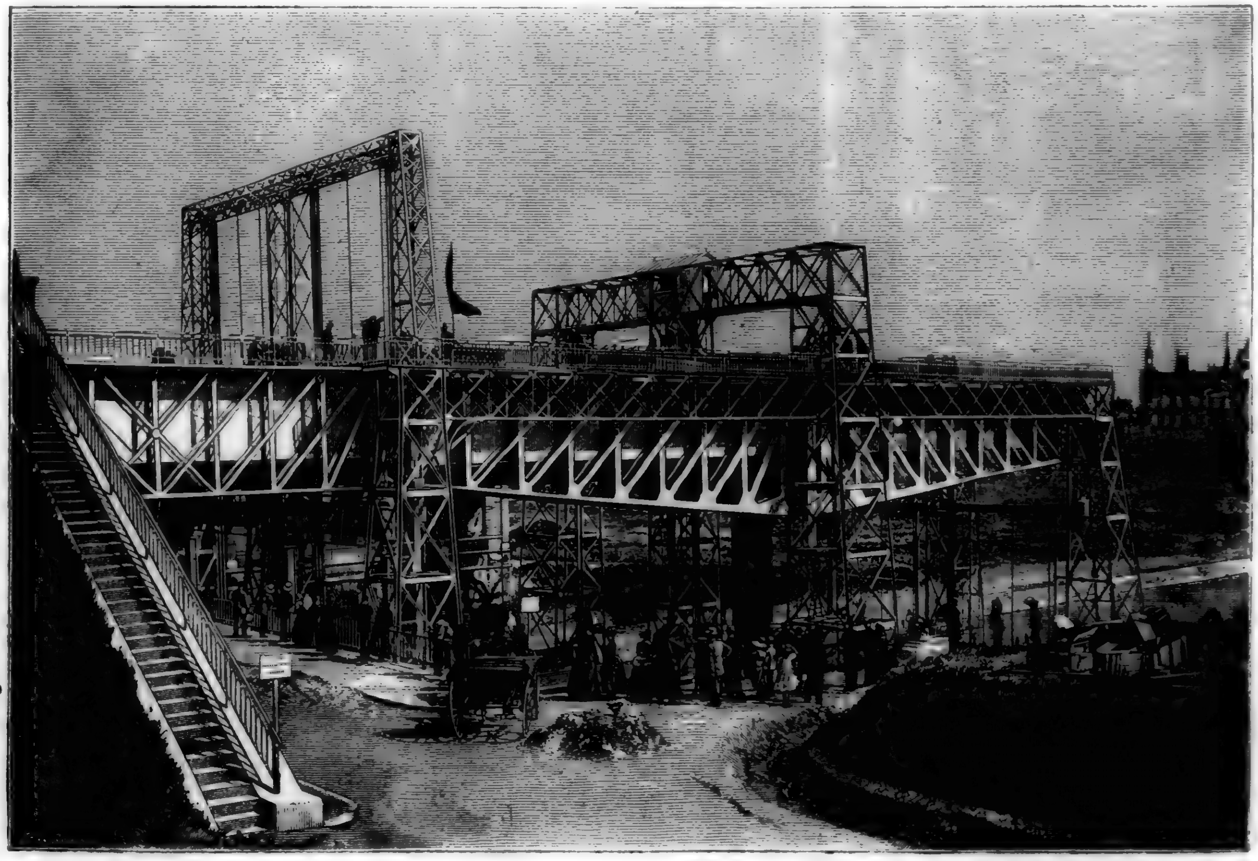
The plan adopted by the Government engineers included the establishment of four hydraulic lifts or locks on the system devised by Edwin Clarke. The first, built at Houdeng-Goegnies, overcomes a fall of 15.397 meters (50.5 ft.), the other three have a lift of 16.933 meters (55.5 ft.) each; the four lifts together thus overcome a difference of level of 66.196 meters (257.5 ft.). The remaining difference of level, which is in all 23.268 meters (77 ft.), will be obtained by six ordinary locks.

The hydraulic lift at Houdeng-Goegnies is shown in the accompanying illustrations, two of which are perspective views, while the other two show a side elevation and a section of the structure.

This lift or lock is composed of two movable basins or locks of iron, each supported by a single hydraulic press. The two presses are connected by a pipe, in which is placed a valve; when one of the lock-basins is at the level of the upper section of the canal, the other stands at that of the lower section, and communication is then opened between the two presses. The water, tending to establish a level between the two, forces one of the locks to descend, while the other ascends; when they arrive at the same level it is necessary, in order to complete the movement, to introduce into the descending lock an excess of weight equal to the weight of water continued in the other one. In the Houdeng-Goegnies lock or lift this excess is furnished by an addition of 0.300 meter to the depth of water, which represents a weight of 74 tons.

The chamber or lock, properly so called, and the metallic structure which supports it, with the gates which close its two ends, weigh 296 tons, and the piston of the hydraulic press weighs 80 tons; each press is capable of sustaining a total weight of 1,048 tons.

The piston of each of these hydraulic presses is of cast iron and is in three parts. The first part or head of the piston supports the lock chamber directly, and has the form of a plate 3.200 × 3.200 meters and 1.400 meters in height; the central portion, which is cylindrical, is formed of eight sections 2.130 meters in height and 0.075 meter in thickness, bolted together; the lower part is a spherical cap 1.000 meter in height.



The press, properly so called, has an interior diameter of 2.060 meters. Its base is a plate of cast iron 0.150 meter in thickness. The body of the press is composed of eight rings each 2.000 meters in height and 0.100 meter thick. Each section is re-enforced by steel rings 0.050 meter thick, shrunk on hot. The upper and the lower rings of each section have a square form and serve as flanges to unite the two adjoining sections. The top ring of the upper section is 1.599 meters in height, and is composed of three parts. The first part below is 1.167 meters in height and formed like the other section of the press. The middle portion, which is not hooped, is formed by a cylinder of cast iron joined to a hollow arch, also of cast iron, which is connected with an arch of the other press by a special system of tubes. In the cylindrical portion of the press leading to the arch there are a series of holes 0.050 meter in diameter. The third or top part of this section contains the stuffing box.

The water in these presses is at a pressure of 14 atmospheres, and all the parts have been calculated to resist a pressure of 80 atmospheres. Tests made on two sections of the cylindrical parts of the presses have given the following results: A section in cast iron 0.100 meter thick, and not hooped, was broken at 146½ atmospheres, after having resisted a pressure of 152 atmospheres. A similar section

hooped with steel was tested up to a pressure of 265 atmospheres without breaking.

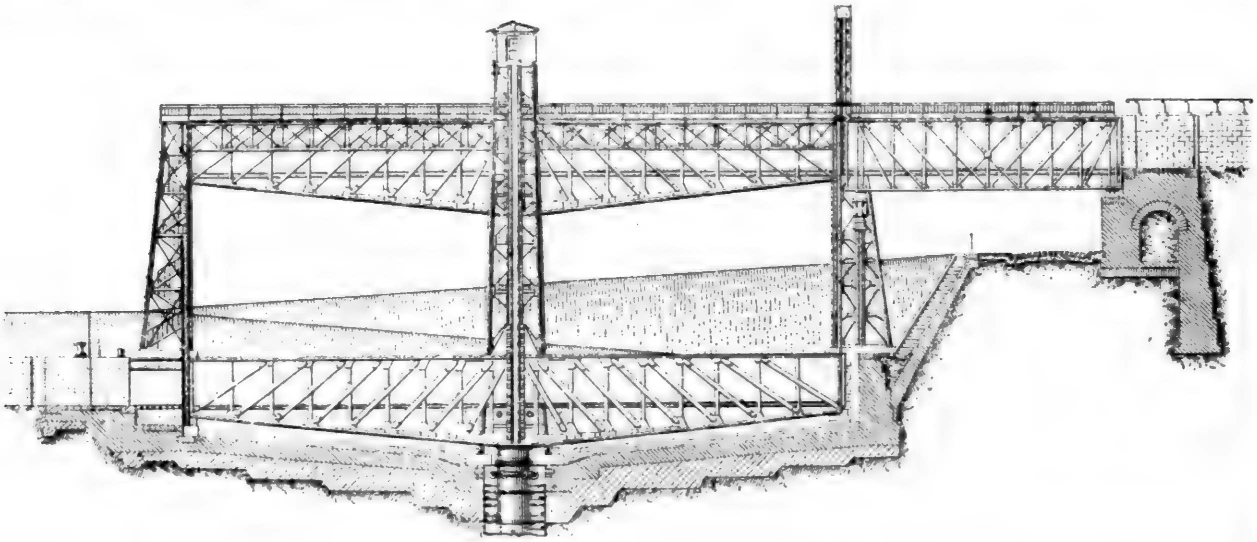
The locks are guided in their movement at six points, the four corners and at each side of the center. The guides at the angles are 3.425 meters in height, and those at the center, 7.692 meters. These guides bear against the trusses which carry the lock, which are very strongly braced.

Above the lock the water of the canal is held back by a vertical wall in which is placed a gate for the passage of boats. The locks descend to the lower level in two large masonry basins made to receive them, as shown in the sectional view. Above and below the locks, when they come into place, are opposite two iron bridges or connections by which they can communicate with the water in the corresponding level of the canal, and the entrance to these

level, and *vice versa*, can be completed in 15 minutes. The actual movement of the locks, with the extra charge of water 0.300 meter in depth, lasts only 2 minutes 50 seconds. The amount of water drawn out of the upper level of the canal at each movement is 74 tons.

The total cost of this hydraulic lift was as follows:

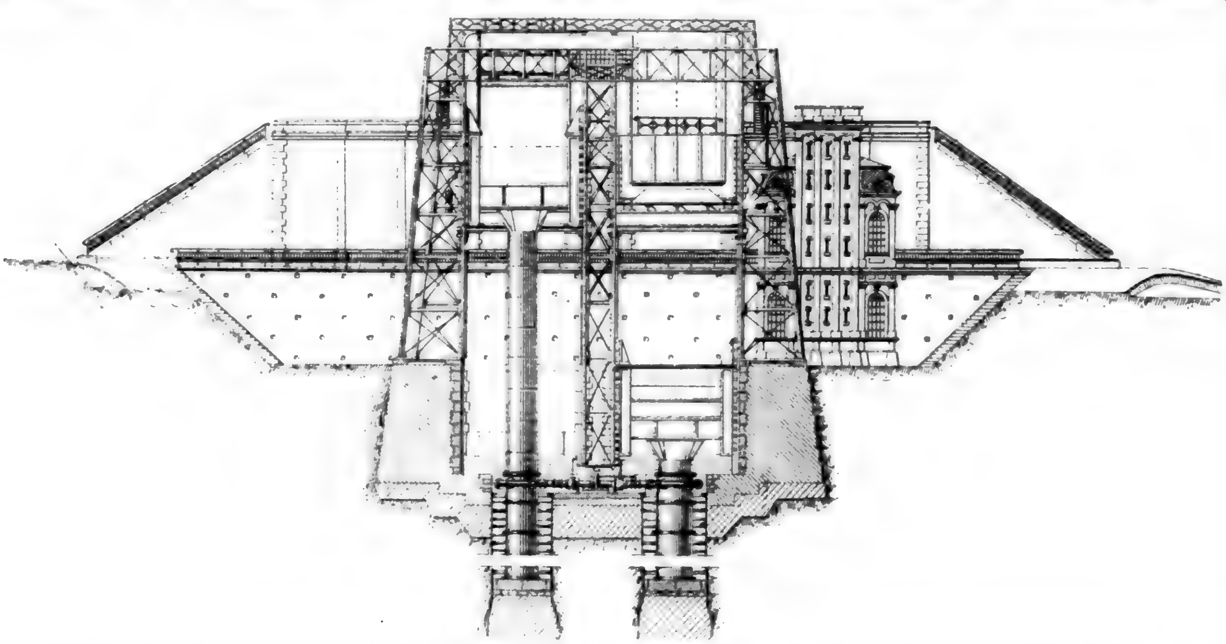
Land	$ 2,250
Excavation, foundations and masonry	80,450
Iron and other metallic work, including all machinery	179,800
House for the men in charge of the lift	5,400
Engineering and contingencies	13,900
Total	$281,800



bridges is closed by gates of the same type as those which close the ends of the lock. The joints between these connecting bridges and the canal are closed by means of

The iron work and machinery was furnished by the Societé Cockerill at Seraing, Belgium.

The first hydraulic canal lift established in Europe was



angle-irons or packing-pieces faced with rubber, one side bearing against the lock and the other against the canal bridge.

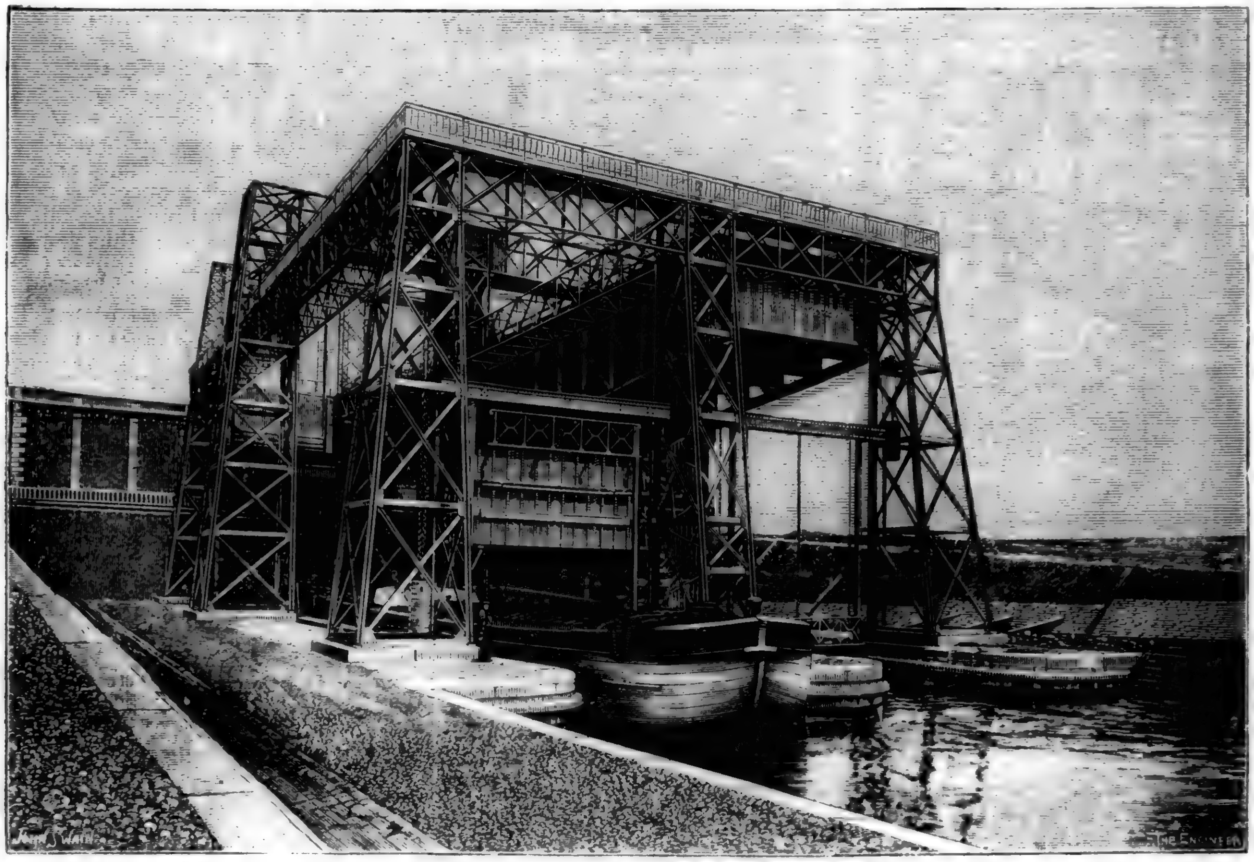
These packing-pieces are raised and lowered, and the gates are opened by means of hydraulic apparatus; the boats are drawn into the lock by hydraulic capstans.

The water used to work the various hydraulic apparatus is furnished by two pairs of double-acting pumps, which pump water into an accumulator at a pressure of 14 atmospheres; each pair of pumps is worked by a horizontal turbine of the Girard system. Experience so far obtained with this lift shows that all operations necessary to pass two boats of 70 tons burden from the upper to the lower

designed by Mr. Edwin Clarke, and was built at Anderton, England, in order to overcome the difference in level of 15.350 meters (50½ ft.) existing between the Mersey and Trent Canal and the river Weaver. In this structure the movable locks or basins filled with water to their usual level weigh about 240 tons, and 15 tons of water gave the additional weight needed to complete the movement. The pistons are 0.910 meter in diameter, and the pressure of water in the hydraulic presses is 37 atmospheres. The length of the lock is 22.850 meters, and its width, 4.730 meters. This lock at Anderton commenced to work in July, 1875, and continued steadily in use until April, 1882, when the service was interrupted by the breakage of one of the

presses. It had been so successful, however, during seven years of continued use, that it was at once repaired and is now again in use.

In France a hydraulic lift for boats has been established on the Neufosse Canal, at Fontinelles, where it took the place of the series of five ordinary locks, which caused serious delay in navigation, as boats took nearly two hours to pass them. The hydraulic lift overcomes an ascent of 13.130 meters. The lock-basins are 40.500 meters long, 5.600 meters wide, and 2 meters in depth. The pistons of the presses are 17.200 meters in length, 2 meters in diameter, and 0.600 centimeters thick. The presses work under a pressure of 25 atmospheres, and the load carried by the piston is 800 tons.



THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

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(*Continued from page 71.*)

CHAPTER III.

CATTLE-GUARDS.

We come next to the question of Cattle-Guards. This question is, without doubt, one of the most vexatious on a small scale with which a railroad company has to deal. At every grade crossing, excepting those occurring in cities and villages, there is the necessity of constructing and maintaining two of these structures, one upon each side of the crossing. The object of cattle-guards is to prevent the passage of live-stock from the highways upon the right-of-way of the road, thus endangering their own lives and obstructing the traffic of the road.

Nearly every railroad company has its own peculiar manner of constructing its cattle-guards, scarcely any two using the same plans in every detail; but whatever plan may be used the object is the same, and that is simply to prevent the passage of live-stock without in any way obstructing the free passage of the trains, and any method of construction that shall accomplish this object at the slightest danger and expense to the road makes the best cattle-guard.

The most ordinary form of cattle-guard is that shown in Plate II, and is the standard guard used upon the St. Joseph & Iowa Railroad. By examining the plate it will be seen that an excavation 10 ft. wide is made across the road-bed, and four piles driven upon each side of this excavation, the top of these piles to be cut off 2 ft. 6 in. below the base of the rail. A 12 × 12 in. cap is placed upon the top of the piles, and then the opening spanned by means of two 12 × 12 in. stringers, 10 ft. long, placed 2 ft. 3 in. in the clear each side of the center of the track, thus giving each rail a full bearing upon the inside edge of the stringer. Upon the top of these stringers are placed ties 6 in. × 6 in. × 10 ft., spaced 14 in. from center to center. These ties are held to the longitudinal stringers by means of two drift-bolts to each tie, placed just outside the rails, as shown in the plan. The tops of these ties are beveled off to a depth of 2 in. on each side and at an angle of 45°, as shown in the drawing. This beveled part is placed up, and the full width of the tie is left under the rails and under the guard-rails, thus giving them sufficient bearing.

The guard-rails are also beveled on top, and are held to each cross tie by means of ¾-in. drift-bolts, as shown in the plan. This form of cattle-guard is more generally used throughout the United States than any other, and as far as preventing the passage of stock over it is concerned, it is very effective; but it possesses so many disadvantages and introduces such an increased element of danger to the running of trains that there appears to be scarcely any excuse for its ever being constructed. As will be seen, it is impossible for any stock to pass it, but if cattle step upon these cross ties, and it is a well-known fact that they very often will, they are sure to slip through and become caught in the guard in such a way that it is impossible for them to extricate themselves, thus presenting a strong probability that the next train that passes, unless the engineer is fortunate enough to see the obstruction in time to stop, will be derailed, and an accident of greater or less extent follow. There are innumerable examples of very costly wrecks—costly both from a financial standpoint and in the number of lives that were lost—having been caused simply by stock

getting caught in such cattle-guards as these. The bill of material is given below:

No. 5. Bill of Material for Cattle-guard. St. Joseph & Iowa Railroad.

9 bridge-ties	6 in. × 6 in. × 10 ft.		270 ft. B. M.
2 guard-rails	6 in. × 4 in. × 10 ft.		40 ft. B. M.
4 stringers	12 in. × 12 in. × 10 ft.		480 ft. B. M.
8 piles, 12 in. diameter and of sufficient length.			
36 drift-bolts, ¾ in. diameter and 8 in. long.			
18 " " ¾ in. " " 12 in. "			

The next form of cattle-guard is the standard T-rail cattle-guard of the Atchison, Topeka & Santa Fé Railroad. As will be seen by an examination of Plates III, IV, and VI, an excavation is made in the road-bed the required width of 10 ft., and then this width spanned by a single stringer under each rail.

Before taking up the peculiar construction of this stringer, as used upon the Atchison, Topeka & Santa Fé, we will call attention to the advantages and disadvantages attending the use of this class of cattle-guard—that is, an opening spanned by a single stringer under each rail. As far as the cattle-guard itself is concerned, it is a great improvement upon the ordinary guard, provided the opening is wide enough and deep enough to allow any stock that attempt to cross and fall into it to fall entirely clear of the track, and upon the Atchison, Topeka & Santa Fé this is the case. In this way, although it may result in certain slight injury to the stock, the track is left entirely clear for the passage of trains, and a great element of danger removed. It does, however, possess in itself an element of danger that does not appear in the ordinary cattle-guard. The opening being spanned by means of a single stringer under each rail, if from any cause one of the trucks in a train happens to be derailed at the time the train passes one of these guards the truck will drop into the excavation, and thus wreck more or less of the train. This is an objection that applies to all openings spanned by single stringers, and is a very great one. The probability, however, of a truck being off the track at just this particular point is, of course, very slight, while in the ordinary cattle-guard the fact that it is there presupposes the presence of cattle, and a great probability that sooner or later some of them will get caught in attempting to cross the track, and cause a wreck to a passing train. Therefore in every way this T-rail cattle-guard, or any form where a single stringer is used to cross an opening, is much preferable to the ordinary form of tie cattle-guard.

Attention should be called to one distinctive feature of this cattle-guard, as used upon the Atchison, Topeka & Santa Fé Railroad, and that is the construction of the T-rail stringer by means of which the opening is spanned.

As will be seen by an examination of Plate V, each stringer is composed of three sections of rail. The size of the rail used corresponds with whatever rail happens to be used on that section of the road. Two sections of rail are placed base to base and riveted together in the shop, the bottom piece being 6 ft. long and the top piece 8 ft., so as to allow the stringer to have a bearing of 1 ft. upon each side of the guard. It has been found where open cattle-guards are used, that 6 ft. is sufficient to prevent the passage of any stock. The block or filler, as shown in the drawing, is made of cast iron, to correspond with the size of the rails used, and five blocks are used in each stringer. The chairs upon which the ends of the stringers rest are also made in the shops, so that the only thing necessary upon the road is the putting together of the different parts of which the stringer is composed—that is, putting the stringer upon the two upright rails, setting the rail upon which the train is to run upon the top of the filler-block, and then introducing the long bolt which holds the rails together, putting on the nut and the jam-nut, and setting the whole thing up. The rails upon which the train runs rest upon the tops of the filler-blocks, and are held in place by the heads of the stringer rails upon each side. When the long bolt is tightened up these running rails are held with great firmness. This stringer is practically indestructible, can be made out of old rails that have done their duty in the track, and thus utilize material which otherwise would be to a great extent valueless.

There is nothing new in this idea of crossing small openings by means of stringers made of old worn-out rails that will not do to run trains upon, but it has been developed to a greater extent upon the Atchison, Topeka & Santa Fé and the Mexican Central railroads, probably, than upon any other roads on this continent. Of course, one cause that has led to this is the great scarcity of wood upon many parts of these roads, but it is an economic question that would well repay our engineers to study more carefully and exhaustively, as the different uses to which these old rails can be economically put is almost without limit, and the expense of the construction of almost any structure, from cattle-guards up to coal sheds and station buildings, by means of old rails, is very slight. It is true that many methods for rerolling steel have been proposed, but none has yet come into general commercial use. The use of old rails in this manner has become much more desirable since the general introduction of steel rails from the fact that steel rails after having once become useless in the track cannot be returned to the rolling mills and rerolled as the old iron rails could be, and thus some new method must be found for the economical use of scrap steel rails.

Plate V shows in detail the construction of the T-rail stringer, with the ordinary 56-lbs. section, as used upon the Atchison, Topeka & Santa Fé. All the dimensions are put upon the plan.

Plate VI shows in detail the construction of the cattle-guard fences. This plan only shows the construction of the fence upon a fill, but from it can be readily seen the construction either in a cut or upon a level section.

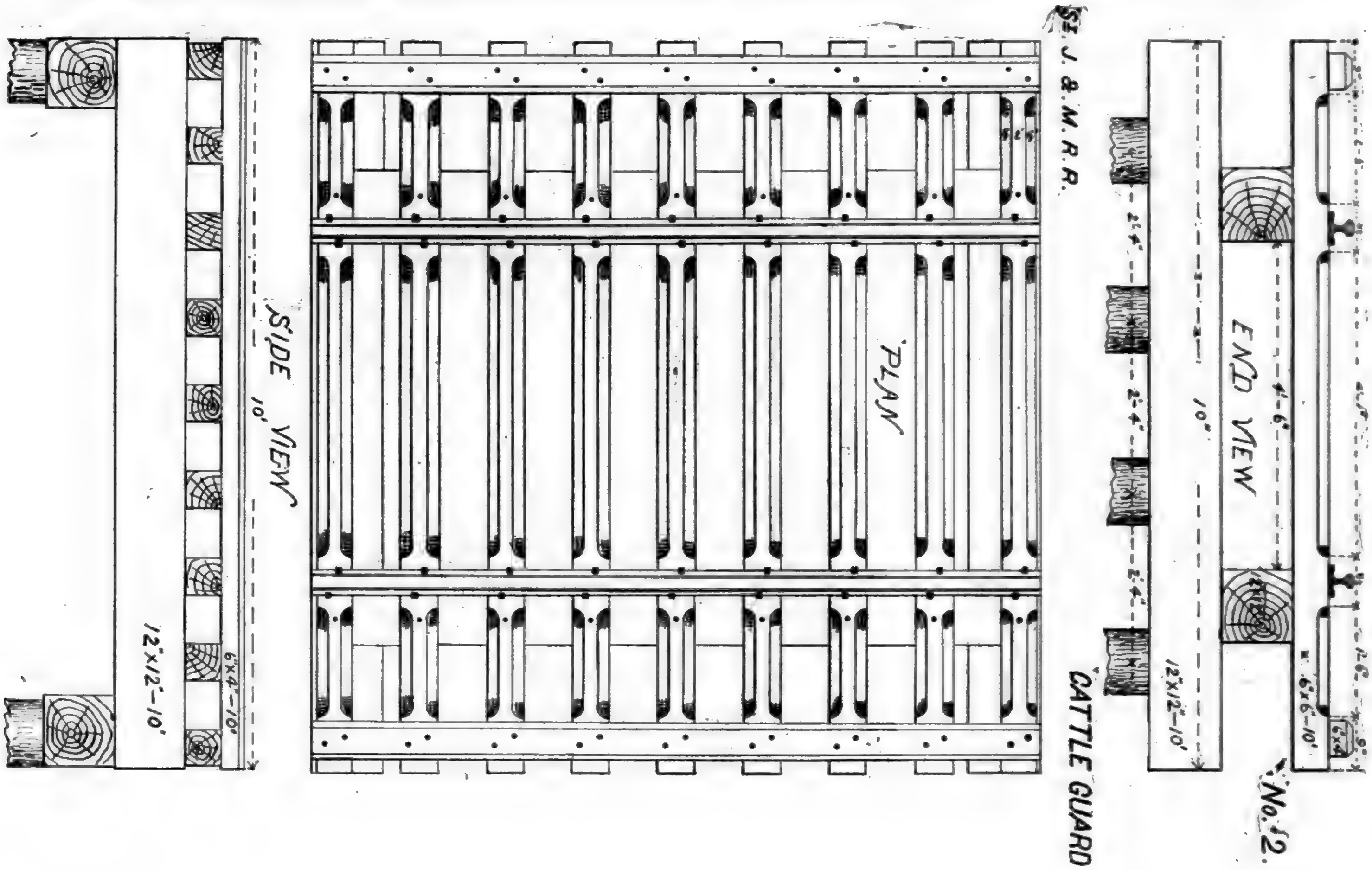
Fig. 3. Plate VI, shows in detail the chair to be used with the T-rail stringer. The bills of material for these cattle-guards are given below:

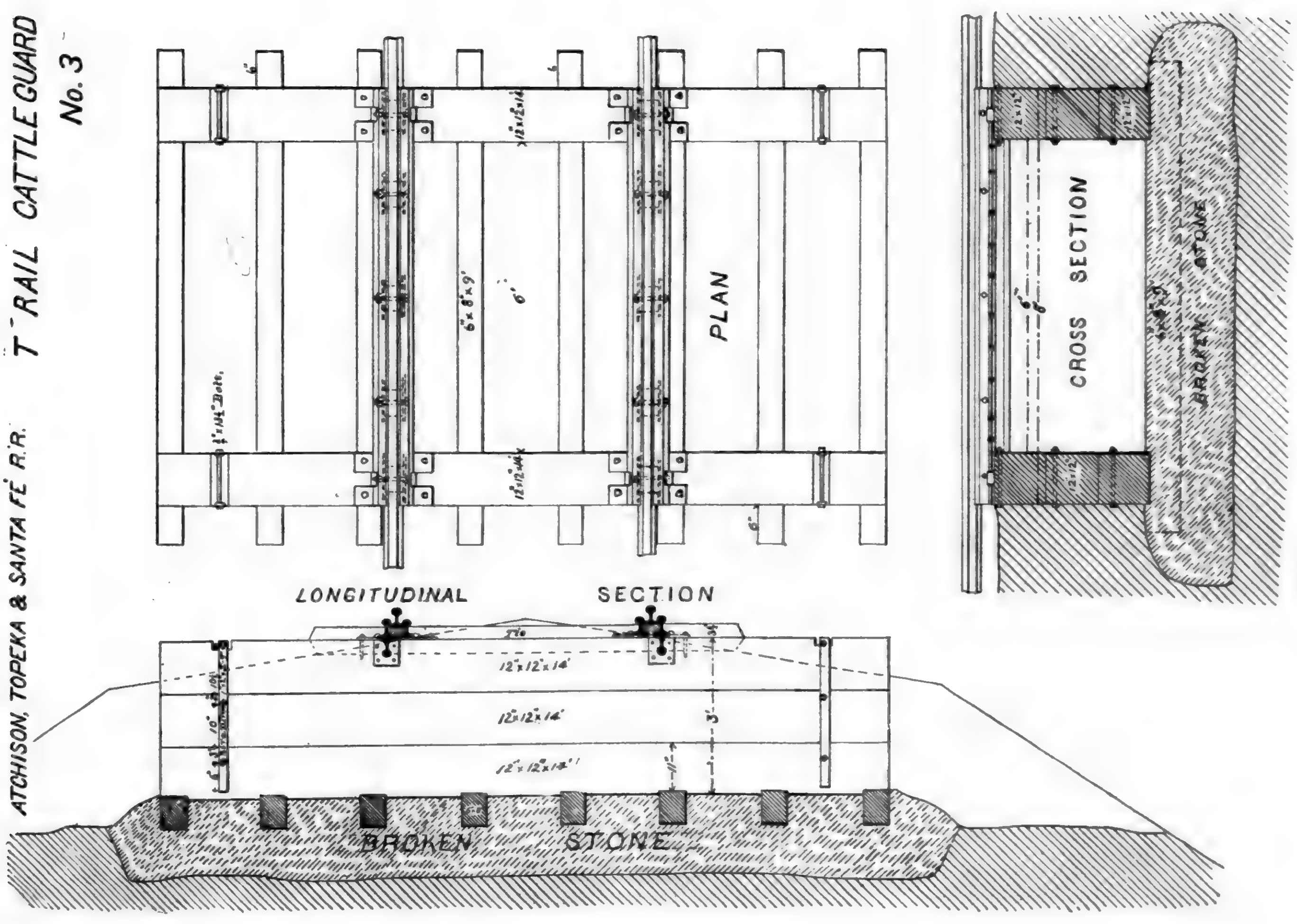
No. 6. Bill of Material for T-rail Cattle-guard. Atchison, Topeka & Sante Fé Railroad.

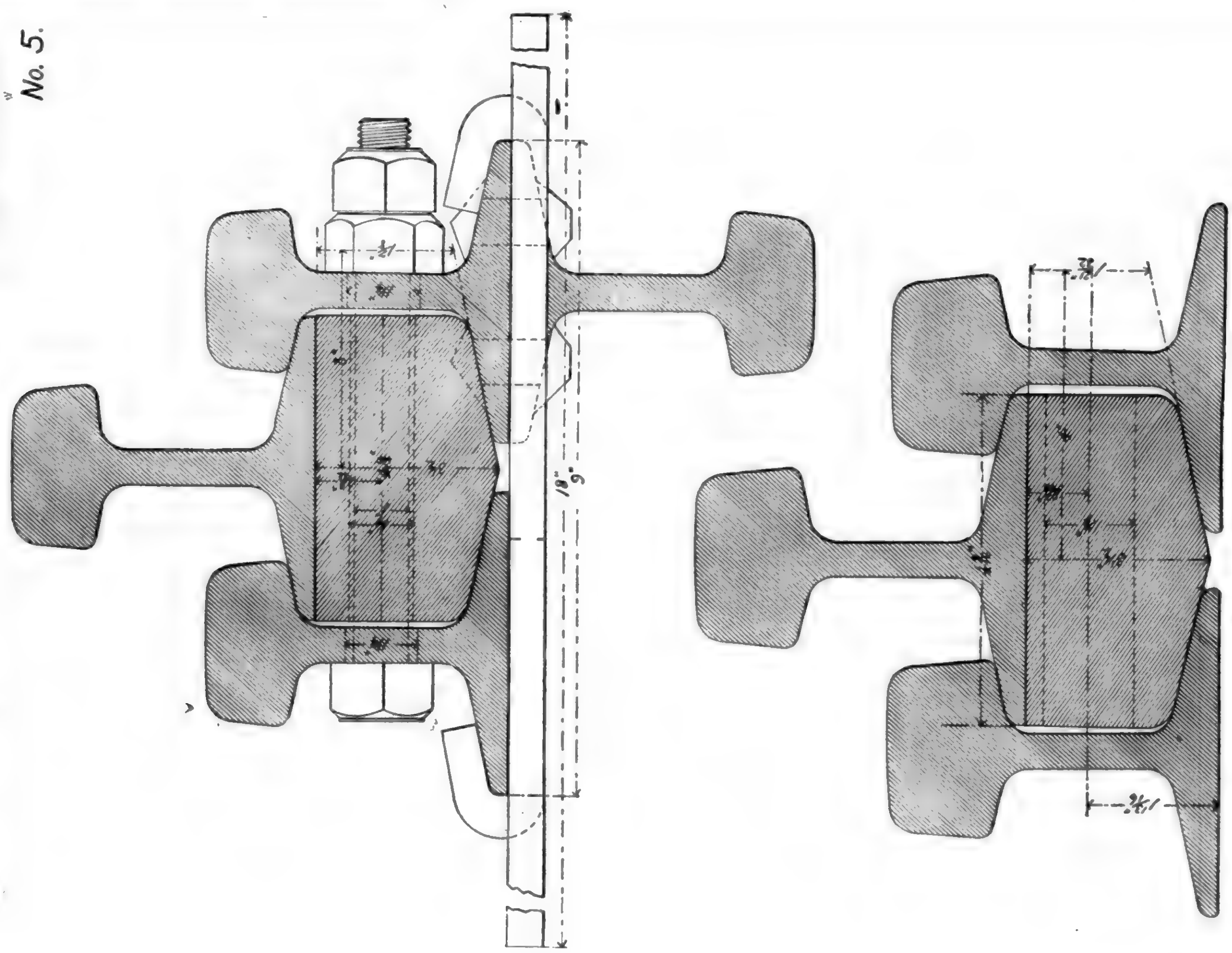
Size.	Material.	Number. Cut.	Fill.	Level.
Cub. yds.	Broken stone	8	8	8
6 in. × 8 in. × 9 ft.	Sleepers	8	8	8
12 in. × 12 in. × 14 ft.	Sills	6	6	6
3 in. × 12 in. × 16 ft.	End of guard (cut to 8 ft.)	3	..	3
6 in. diam., 10 ft. long.	Good cedar posts	4	4	4
6 in. diam., 10 ft. long.	Good cedar posts	4	4	4
1 in. × 6 in. × 16 ft.	Fencing stuff	12	16	12
1 × 2 × 2–9	Wrought-iron straps, ¾ in. hole	8	8	8
¾ in. × 13½ in.	Bolts and nuts, thread 3 in.	12	12	12
	Chairs as per plan, Plate VI	4	4	4
	Track-spikes	16	16	16
6 ft. long	T-rails, riveted together	2	2	2
8 ft. long	T-rails, riveted together.	4	4	4
	Cast-iron blocks, as per plan, to correspond to size of rail	10	10	10
1 in. × 8¾ in.	Bolts with nuts and jam-nuts	10	10	10
12d	Nails	3 lbs.	3 lbs.	3 lbs.
⅜ in × ⅜ in. × 7 in.	Spikes for end-boards	40	..	40

No. 7. Bill of Material for T-rail Cattle-guard. Atchison, Topeka & Santa Fé Railroad.

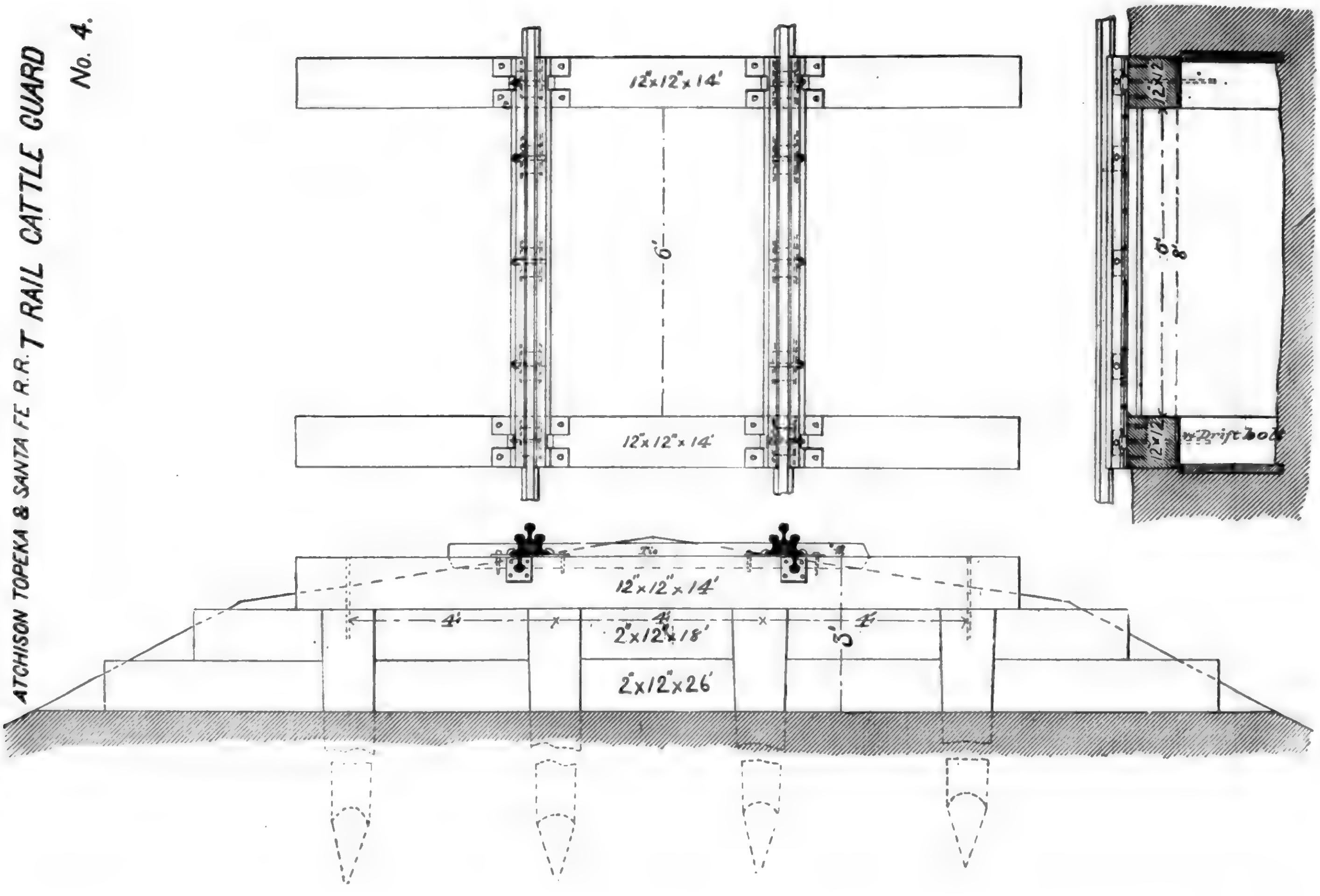
Size.	Material.	Number. Cut.	Fill.	Level.
12 in. diam. (small end).	Piles, length required	8	8	8
12 in. × 12 in. × 14 ft.	Sills	2	2	2
2 in. × 12 in. × 14 ft.	Retaining plank	4	..	4
2 in. × 12 in. × 18 ft.	Retaining plank	..	2	..
2 in. × 12 in. × 18 ft.	Retaining plank	..	2	..
2 in. × 12 in. × 18 ft.	Retaining plank (cut to 9 ft.)	..	2	..
3 in. × 12 in. × 16 ft.	End of guard (cut to 8 ft.)	3	..	3
6 in. diam., 12 ft. long.	Good cedar posts	4	4	4
6 in. diam., 8 ft. long.	Good cedar posts.	4	4	4
1 in. × 6 in. × 16 ft.	Fencing stuff	12	16	12
⅞ in. × 20 in.	Drift-bolts	4	4	4
30d	Nails	3 lbs.	3 lbs.	3 lbs.
	Chairs as per plan, Plate VI	4	4	4
	Track-spikes	16	16	16
6 ft. long	T-rails, riveted together	2	2	2
8 ft. long	T-rails, riveted together	4	4	4
	Cast-iron blocks, as per Plate V, to correspond to size of rail	10	10	10
1 in. × 8¾ in.	Bolts, with nuts and jam-nuts.	10	10	10
10d	Nails	2 lbs.	2 lbs.	2 lbs.
⅜ in. × ⅜ in. × 7 in.	Spikes for end-planks	40	..	40


St. J. & M. R.R.
SIDE VIEW
10'
12"x12"–10'
PLAN
END VIEW
10'
12"x12"–10'
CATTLE GUARD
No. 2.

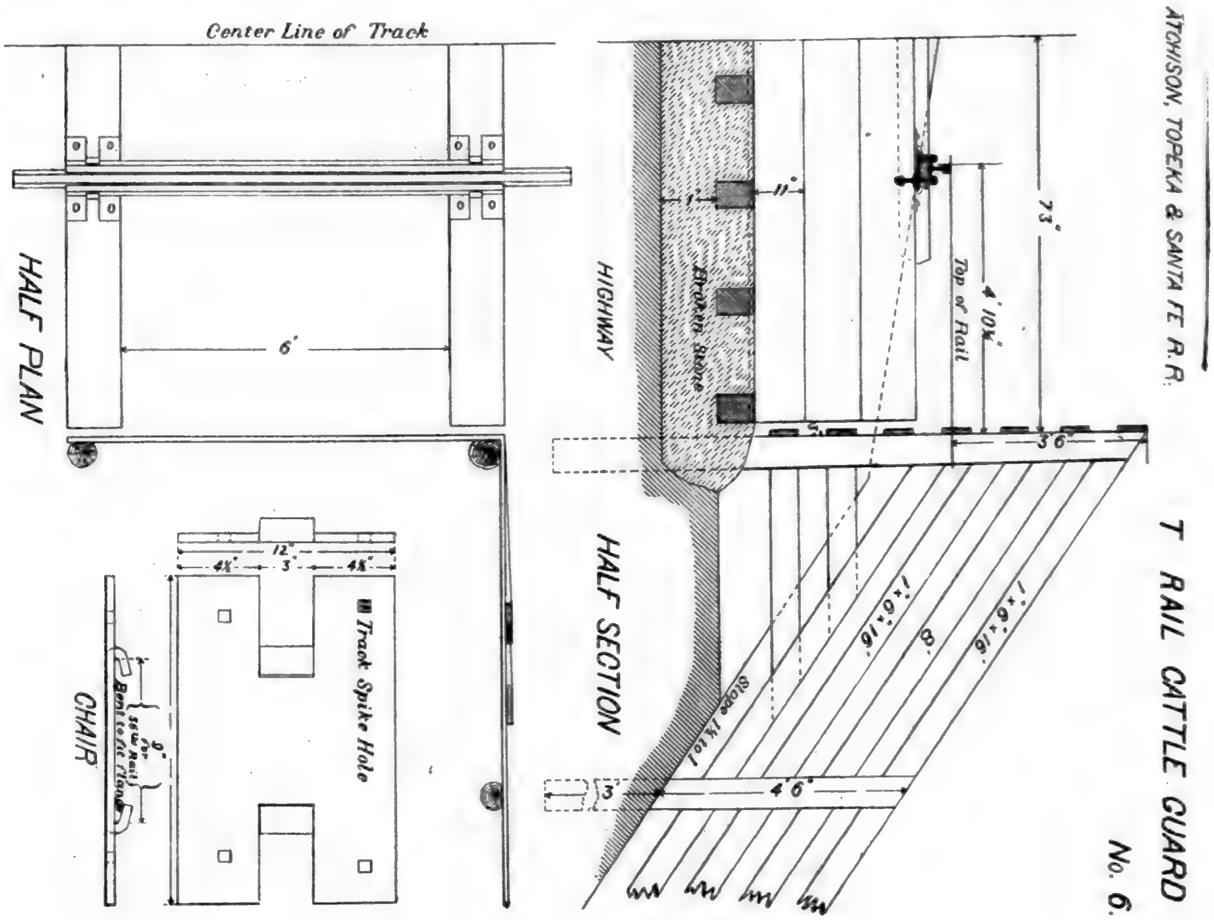

ATCHISON, TOPEKA & SANTA FE R.R.
T RAIL CATTLE GUARD
No. 3
PLAN
CROSS SECTION
BROKEN STONE
LONGITUDINAL SECTION
12"x12"x14'
12"x12"x14'
12"x12"x14'
BROKEN STONE

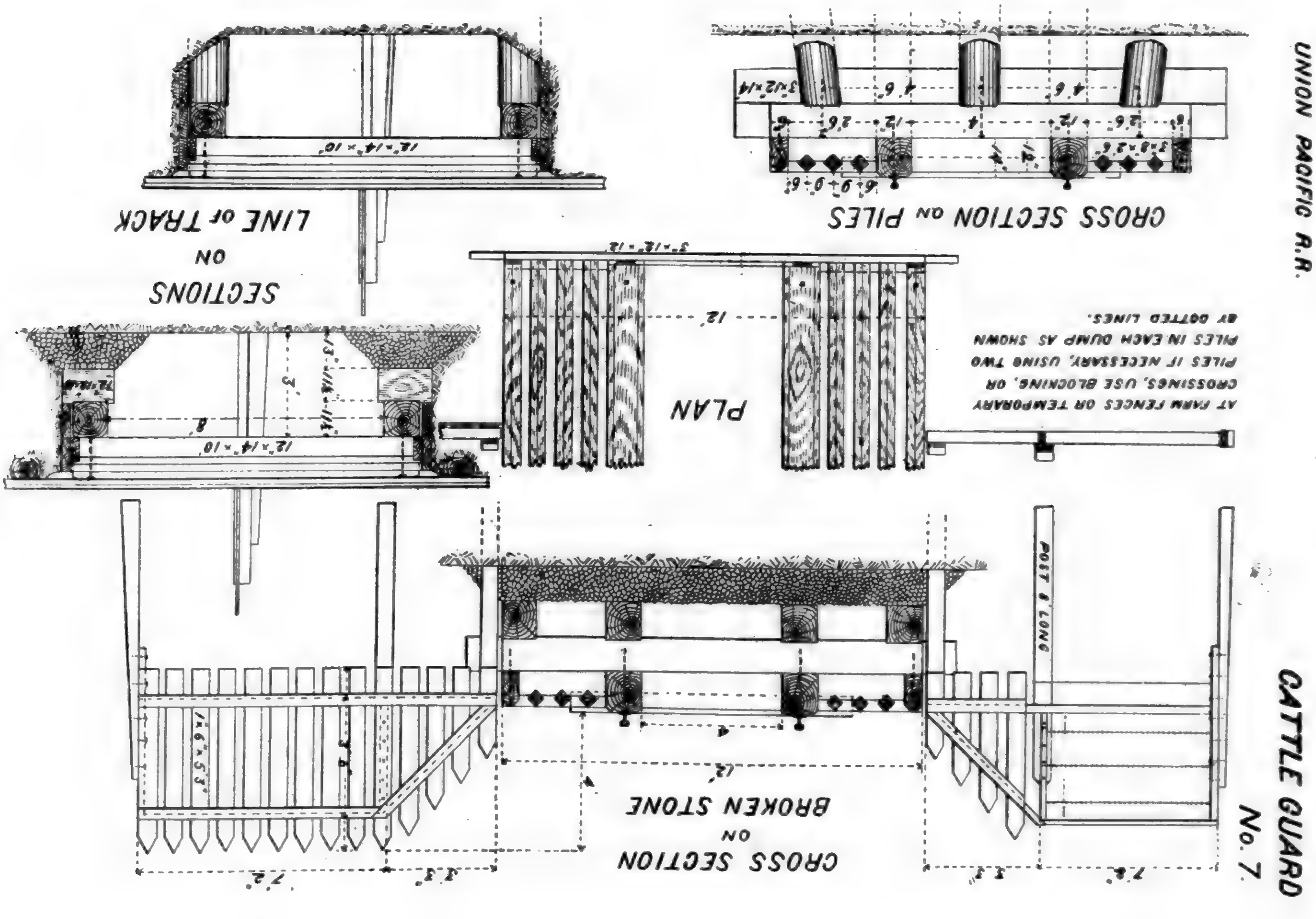


ATCHISON TOPEKA & SANTA FE R.R. T RAIL STRINGER No. 5.



ATCHISON TOPEKA & SANTA FE R.R. T RAIL CATTLE GUARD No. 4.


ATCHISON, TOPEKA & SANTA FE R.R.
T RAIL CATTLE GUARD
No. 6.
Center Line of Track
HALF PLAN
HALF SECTION
CHAIR
Track Spike Hole
HIGHWAY
Broken Stone
Top of Rail


UNION PACIFIC R.R.
CATTLE GUARD
No. 7.
CROSS SECTION ON PILES
SECTIONS ON LINE OF TRACK
PLAN
CROSS SECTION ON BROKEN STONE
AT FARM FENCES OR TEMPORARY CROSSINGS, USE BLOCKING, OR PILES IF NECESSARY, USING TWO PILES IN EACH DUMP AS SHOWN BY DOTTED LINES.
POST 8' LONG

The next form of cattle-guard is the standard guard of the Union Pacific Railway, Plate VII. By an examination of the drawing it will be seen that this is simply a cattle-guard spanned by a single stringer under each rail, with the spaces upon the outside of each rail and also between the rails partially filled up by means of longitudinal slats running the whole width of the guard. These slats are composed of 4 × 4 in. stuff set in notches with their sides inclined at an angle of 45° to the horizontal.

Without doubt, as a mere prevention to the passage of cattle, this form of guard is as effective as any other, but it possesses all the elements of danger of the ordinary cross-tie guard—that is, the danger of the cattle being caught in it and thus derailing the trains, and also the disadvantage connected with the single-stringer cattle-guard, as the slats, although strong enough to catch and hold firmly any stock that may fall upon them, are still not strong enough to support a derailed truck in case there should be one in any train that might pass over it.

Possibly this form of guard may possess advantages that are not evident to the Author, which may be some excuse for its use upon such a road as the Union Pacific, but from his standpoint it certainly seems to possess all the evils of every other class of cattle-guards and none of the advantages.

The bill of material for this cattle-guard is given herewith:

No. 8. Bill of Material for Standard Broad-gauge Cattle-guard.

Union Pacific Railway.

2 track-stringers	Oak	12 in. × 12 in. × 10 ft.
2 caps or sills	Oak	12 in. × 12 in. × 12 ft.
6 slats	Oak or pine	4 in. × 4 in. × 10 ft. 2 in.
2 outside stringers	Pine	6 in. × 12 in. × 10 ft.
8 furring strips	Pine	1 in. × 6 in. × 2 ft.
2 plank	Oak or pine	3 in. × 12 in. × 12 ft.
— plank (see note)	Oak or pine	3 in. × 12 in. × 14 ft.
4 slat-supports	Oak or pine	3 in. × 8 in. × 2 ft. 6 in.
8 blocks (if used)	Oak or pine	12 in. × 12 in. × 18 in.
— piles (if used)	Oak	
8 drift-bolts for stringers	Wro't iron	⅞ in. × 22 in.
— drift-bolts for piles	Wro't iron	⅞ in. × 22 in.
12 boat-spikes	Wro't iron	½ in. × 10 in.
Two fence-panels.		
6 posts	Oak or cedar	8 ft. long.
27 pickets	Pine	1 in. × 6 in. × 5 ft. 3 in.
4 battens	Pine	1 in. × 4 in. × 12 ft.
4 pieces	Pine	2 in. × 4 in. × 12 ft.
2 pieces	Pine	3 in. × 4 in. × 12 ft.

We come now to the last, and, in some respects, the best form of cattle-guard—that which is being used to some extent upon the Lake Shore & Michigan Southern Railway, and which is shown in Plate VIII.

The characteristic feature of this cattle-guard is that there is no opening made in the track at all, and no special preparation required in the road-bed. The only thing that is necessary is that the ties which are within the limits of the guard should be moderately even upon the top, and for this reason it is the custom to use sawed ties for this purpose; but this is not an absolute necessity. The rail is laid in the ordinary manner upon the ties, and the ties tamped up upon the ballast, the same as any other ties in the road. Then upon the top of these ties are placed slats 2½ in. by 4 in. and 10 ft. long, the top of these slats being beveled to a depth of 2 in. on each side, leaving the top of the slat ½ in. wide; these slats run in the direction of the rail, and are placed upon the ties, being held 2 in. apart by means of filler-blocks 2 in. × 2 in. × 8 in. at each end of the slats. These slats and fillers are held together in sections by means of long bolts running through each end, as shown in the drawing. By this means each section can be taken up and the track work carried on underneath in the usual manner and then replaced and spiked to the ties. The ends of these slats are beveled off, in order to do away with the danger of their being caught and torn up by any hanging brake rods there may be in the trains.

In the case of double track it is only necessary to introduce three extra ties or three ties of length sufficient to cross the intervening space between the tracks. This space is covered with slats, as shown in the drawing, the same as the remaining portions of the track.

As far as turning cattle goes, it has been found by actual experiment that this form of guard is fully as effective as any other. When the cattle step upon these slats they turn back and never attempt to walk over them, but in case the slats are not long enough they will pass over by jumping. The great advantages which this guard possesses over any other form are as follows:

There is no opening in the track of any sort, and this eliminates all danger from either a truck dropping through the opening or cattle getting caught in it. It requires no special preparation or work in the road-bed, and it is much less expensive than any other form of cattle-guard that has been presented. It requires no skilled labor, all the various parts can be put together in the shops, and sent to any section foreman, who has simply to fasten them to the ties in the proper places and construct the fences upon each side. The amount of material necessary is comparatively nothing, and thus, taking everything into consideration, this form of cattle-guard possesses none of the disadvantages attendant upon the other forms, while it possesses great inherent advantages.

The following is the bill of material for this guard:

No. 9. Bill of Material for Slat Cattle-guard.

Lake Shore & Michigan Southern Railway (Single Track).

20 slats, as per plan, Plate VIII	2½ in. × 4 in. × 10 ft.
38 filler-blocks, as per plan, Plate VIII	2 in. × 2 in. × 8 in.
4 iron ⅝ in. rods, with nuts and washers	18 ft. long.
2 iron ⅝ in. rods, with nuts and washers	29 ft. long.
2 iron ⅝ in. rods, with nuts and washers	27 ft. long.

Of course, in order to make any cattle-guard thoroughly effective, the fences upon each side must be brought down to the guard, and in order to bring them close to it without interfering with the passage of the trains, they should be sloped at an angle of 45°, as shown in the different plates.

CHAPTER IV.

BUMPING-POSTS.

Bumping-Posts should be placed at the end of all stub switches, and at the end of all tracks where the track stops short without being connected with any other continuous line of track. The object of the bumping-post is to prevent the cars from running off the ends of the rails.

They are of great use upon stub switches in all station yards, owing to the usual extreme carelessness of the engineers in switching.

They should also be used in every terminal station where the trains all run into the station and then back out. The term "terminal station" is here used in contradistinction to a "through station," or one where the trains run entirely through.

Plate IX shows the details of construction of two standard bumping-posts. The manner of construction shown in figs. 1 and 2 is much less expensive than that in figs. 3 and 5, but it also has much less strength, and in any case where they are liable to be brought into use, the post shown in figs. 3 and 5 is by far the best.

The following are bills of material for the two bumping-posts:

No. 10. Bill of Material for Bumping-post No. 1.

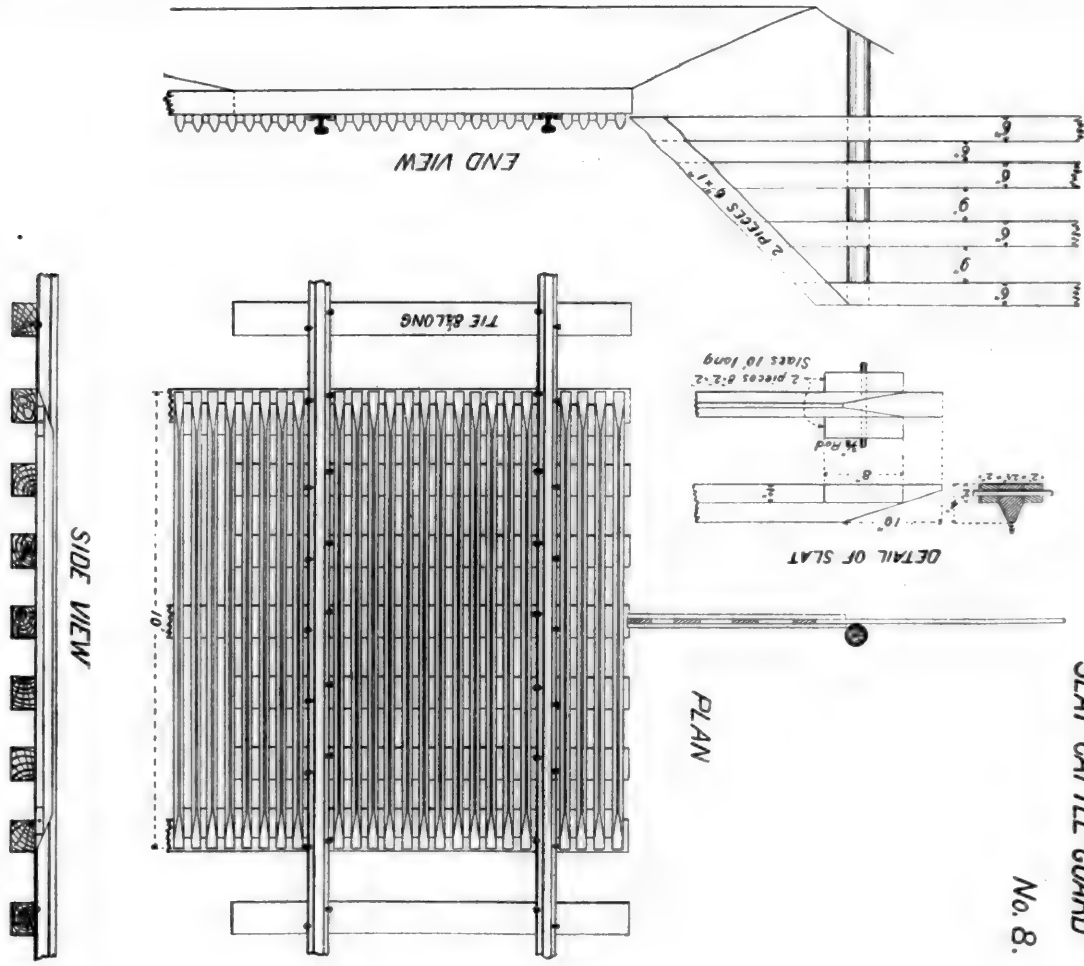
(Plate 9, figs. 1 and 2.)

1 piece	14 in. × 14 in. × 8 ft. 5 in.
1 piece	14 in. × 14 in. × 30 ft.
1 piece	14 in. × 14 in. × 16 ft.
1 bolt	1¼ in. × 15 in., with nut and washer.
2 bolts	1¼ in. × 27 in., with nut and washer.
1 rod	1¼ in. × 7 ft. 3 in., with head, nut, and washer.
1 casting	2 in. × 14 in. × 20 in.

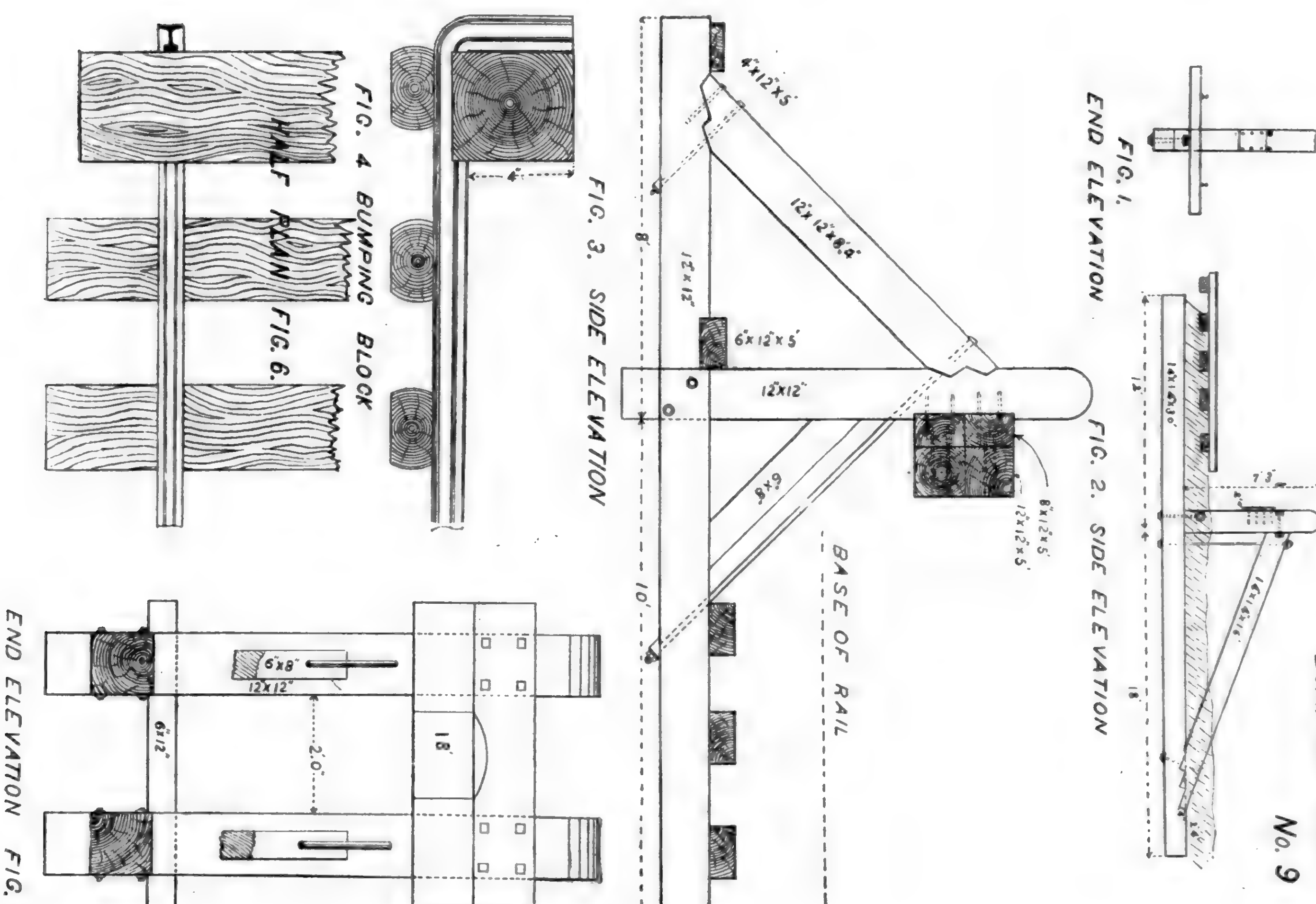
No. 11. Bill of Material for Bumping-post No. 2

(Plate 9, figs. 3 and 5.)

2 pieces	12 in. × 12 in. × 18 ft.
2 pieces	12 in. × 12 in. × 5 ft.
2 pieces	8 in. × 12 in. × 5 ft.
2 pieces	12 in. × 12 in. × 8 ft. 6 in.
2 pieces	12 in. × 12 in. × 9 ft. 6 in.
2 pieces	6 in. × 8 in. × 4 ft. 6 in.



SLAT CATTLE GUARD
No. 8.



BUMPING POST
No. 9

1 piece	4 in. × 12 in. × 5 ft.	
4 bolts	$\frac{3}{4}$ in. × 17 in.	
2 rods	$1\frac{1}{8}$ in. × 8 ft. 3 in.	
4 bolts	$\frac{3}{4}$ in. × 15 in.	
34 boat-spikes	18 in. long.	
16 spikes	12 in. long.	

Figs. 4 and 6 give an elevation and half-plan of a bumping-block, which is a substitute for a bumping-post. As will be seen by the drawing, the ends of the rails are simply turned up, and a piece of 14 in. × 14 in. square timber fitted tightly into the angle. The bill of material—a very brief one—is as follows :

NO. 12. BILL OF MATERIAL FOR BUMPING-BLOCK.
(Plate 9, figs. 4 and 6.)

1 piece....................14 in. × 14 in. × 7 ft.

Although much cheaper than bumping-posts, these bumping-blocks are inferior to them in every way, and should only be used upon temporary tracks.

(TO BE CONTINUED.)

SPIRALLY-WELDED STEEL TUBES.

(Abstract of remarks by J. C. Bayles, before the Franklin Institute, Philadelphia.)

THE manufacture of light steel pressure pipes made from strips of metal wound laterally and hammer-welded, is an entirely new industry, employing means and producing results wholly unlike any before known in the arts.

In iron and steel pipe, it is desirable to use no more material than is needed to give the strength desired. This is true of all products, the progress of the arts tending steadily to a good constructive use of material, to secure a maximum of strength with a minimum of dead weight. As the rule, lap-welded tubes are enormously heavier than anything in the service to which they are subjected warrants. They are made so for no other reason than that lighter stock than that employed in making them cannot be used. If the stock is heated in sheets, drawn from the furnaces at the welding temperature, shaped on a mandrel and welded, a considerable body of stock is needed to hold the heat during the shaping and welding processes. With thin sheets one of two things would happen : either the metal would chill instantly when drawn from the furnace and refuse to weld, or, if hot enough, would collapse upon itself, defeating all efforts to shape and weld it. Light pipes would have been made by lap-welding long ago had it been possible. As it is, they are much heavier than their strength calls for, the longitudinal weld being, as the rule, a line of weakness. In spirally-welded pipes we have the material used to the very best advantage. The weld, instead of being a line of weakness, is a spiral re-enforcement. A circumferential twisting strain is not created transversely to the weld, but longitudinally ; or, to be more accurate, obliquely ; and such pressure does not tend to open the seam, as in the case of a longitudinal weld, but to close it. The behavior of a spirally-welded pipe under pressure is illustrated by a very simple experiment. Roll a ribbon of paper into a spiral tube, as children make lamp-lighters, pinch one end tightly shut and blow in the other. It will be found that the first effect of internal pressure is to tighten the seams, and the paper may be burst before any air will leak out between the edges of the parts in contact. I have seen a defective spirally-welded pipe leak under 20 lbs. pressure, become tight at 50 lbs., and remain tight up to 350 lbs. per square inch. Under an internal bursting strain, the strength of a spirally-welded tube is found in the testing machine to be as great as the theoretical strength of the stock.

The process of manufacture is simple and inexpensive, but has entailed many and serious difficulties. These, however, have been overcome. Steel of suitable quality—*i.e.*, weldable, and having a tensile strength of 65,000 lbs. per square inch, with about 50 per cent. reduction of area, and 15 to 18 per cent. elongation, is rolled in grooves to the proper width, and as long as may be convenient. These strips are welded end to end in a machine built for the purpose, which works very well. As they are welded into long bands, the strips are rolled on large reels, which are passed to the pipe machines.

The pipe machine is shown in the accompanying illustration. Its essential features are a guide-table for the skelp, adjustable to the desired angle ; feed-rolls, to pass it forward with an intermittent progress, so that it shall advance when the former is raised and be at rest when it falls ; a former, to curve the metal to the desired radius, also adjustable ; a furnace, to heat the metal ; a hammer, to weld it, and an anvil, to support the pipe and receive the shocks of the hammer. No mandrel is used. The pipe in the forming process is held in place by a pipe-mould, which is a cylindrical shell, within which the pipe rotates as the stock is fed in. The anvil is of considerable mass, steel-faced, and extends the entire width of the skelp. The hammer is light, and at normal speed strikes 350 blows per minute. The heating is done in a furnace so constructed as to heat both the edges to be united for the space of several inches ahead of the point at which the welding is effected. The upper skelp enters the furnace flat, and the lower skelp curved, having already been through the forming-jaws. The heat is imparted by one or two blow-pipes of water, gas, and air, discharging upon the metal through passages of suitable form in the refractory lining of the furnace. One gas-flame has been found sufficient, but two work better ; and besides being more convenient to control, they heat the metal more rapidly and permit an accelerated feed. As very little gas is wasted, the greatest economy attends the most rapid production of pipe, irrespective of the quantity burned, which in any case is about 30 ft. per foot of welded seam. The speed of production depends, as stated, upon the thickness of stock to be heated, and the relation of width of skelp to diameter. It averages a foot per minute to each machine, and it is probable this average can be raised considerably. The machines are so nearly automatic in operation that very little skilled labor is needed in running the plant. The operator has his gas, air, and feed under control by convenient means, and varies their relations until he has them just as he wants them. He can see the edges as they emerge from the furnace, and about all the skill he needs is that which will enable him to judge by its color whether the iron is above, below, or at the welding-heat. Unskilled labor prepares the stock and removes the finished product. The ends of the pipe are cut square by suitable machinery without reversing, and after testing and treating with asphalt, the pipe is ready for shipment. As may be supposed, all the difficulties of mechanical development have centred in the pipe machine. To make this satisfactory in operation has probably been no more serious task than is usually entailed in the effort to make old mechanical motions perform new functions, but it has consumed a great deal of time and money.

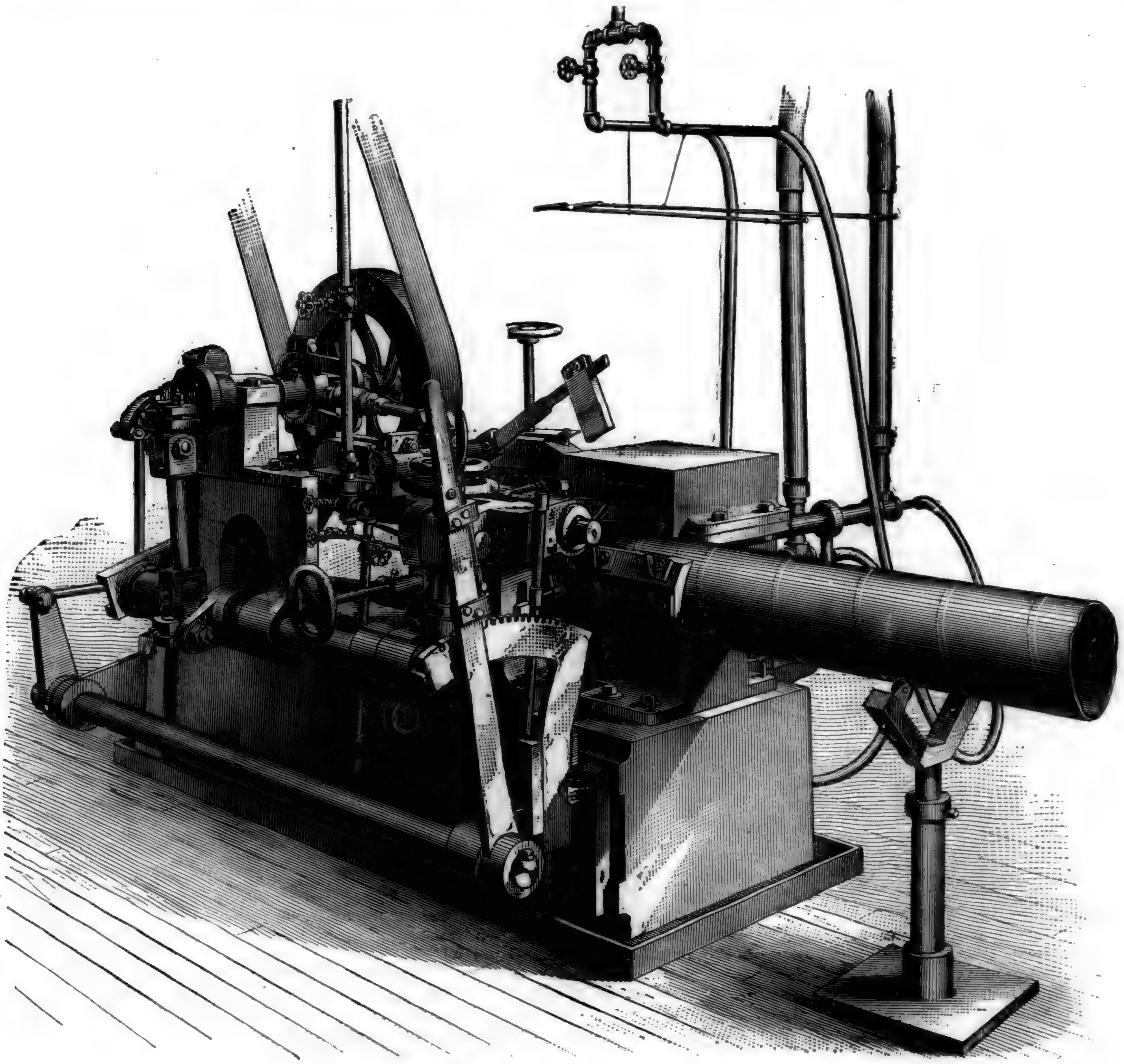
The strengths attainable in light pipe, if the material is used to the best advantage, are quite surprising. A 6-in. pipe, made of No. 14 gauge iron of good average quality, showing under test 33,000 lbs. elastic limit and 50,000 lbs. ultimate strength, has a proof strength of 913 lbs. per square inch, and an ultimate strength of 1,383 lbs. per square inch. A 12-in. pipe of the same stock has a proof strength of 456 lbs. and an ultimate strength of 691 lbs. If a good grade of soft steel is used instead of iron, the 6-in. pipe will carry 1,106 lbs. pressure without deformation, and will not burst under 1,800 lbs. ; the 12-in. pipe can be tested to 475 lbs., and will carry 900 lbs. without fracture. This is very practical pipe. Using the same diameters and gauges of stock for comparison, we find that the 6-in. spirally-welded pipe weighs 5.2 lbs. per foot against 18.77 lbs. per foot for standard lap-welded pipe, and 28.28 lbs. for medium cast-iron pipe ; the 12-in. spirally-welded pipe weighs 10.46 lbs. against 54.65 lbs. for lap-welded, and 77.36 for medium cast iron.

Owing to its superior advantages, we shall use steel exclusively in future. It is 25 per cent. stronger than good iron, works better and costs less per pound.

The advantages of spirally-welded tubes over any other form of pressure pipes, as regards economy of transportation and handling, are very marked, as appears from comparisons of weights.

The question of durability in service is one which naturally suggests itself when light steel or iron pipes are discussed. Experience on the Pacific Coast seems to have

settled this question, as the cheap expedients adopted for water-conveyance during the days when hydraulic mining was most extensively conducted, have been followed ever since in permanent exgineering works. The best attainable data on this subject which I have found are presented in a paper read by Hamilton Smith, Jr., before the British Iron & Steel Institute. Much of the information contained pulled off by the adobe clay in which most of them are laid; but they have a record of useful life since 1853, and many towns are supplied with water under considerable heads from pipes of this kind which have been more than 20 years in service. A welded pipe carefully coated with asphalt should, with fair treatment, have a record at least as good, and probably much better.



MACHINE FOR MAKING SPIRAL-WELD TUBES.

in this paper is quite surprising, especially in the case of the two mains across Humbug Cañon. These pipes were laid in 1868.

They are of 26 in. diameter, 1,194 ft. long, of common iron $\frac{1}{16}$ in. in thickness, single-riveted. During all this time they have been delivering water under 120 ft. head, and Mr. Smith gives the maximum tensile strain in pounds on the metal per square inch as 11,500. Large as these figures look, they are simply the result of applying to the conditions given in Rankine's well-known formula for their cylindrical shells.

Riveted pipe in its best estate labors under the disadvantage of inherent structural weakness, and liability to rust between the overlapping edges and around the rivets. Pipes of this character on the Pacific Coast are very roughly tarred in position, and the coating is quite liable to be

The coupling of light-pressure pipes involves no difficulties, but it entails new methods. These are convenient and inexpensive, and make perfectly tight joints. The couplings are chiefly of cast iron, and their form depends upon the service in which the pipe is to be employed. Steam, water, petroleum, compressed air and gas, all present different problems in couplings, but no difficulties which have not already been fully met. The couplings are as practical as the pipe. The one generally preferred is the "trumpet flange." The pipe is slipped through the flange, and the projecting end is expanded and laid flat against the face of the flange. The ends of the pipes are thus brought in contact with the gaskets, making perfect joints under all circumstances.

Spirally-welded tubes are adapted for every use calling for pressure pipes. In the paper, before referred to, Mr.

Hamilton Smith, Jr., after reciting American engineering experience with light iron tubes, concludes as follows :

"The query presents itself : Why should not wrought iron or, still better, steel, be used for conduit pipes in preference to cast iron ? If it answers the desired purpose in California, why should it not do so in other parts of the world ? To one, like myself, who has for years been accustomed to the California practice, it seems as irrational to build a pipe of cast iron carrying water under considerable pressure, as it would be to build a suspension bridge with the supporting chains made of cast iron.

"Experience in the United States has shown that the practicable limit of size for cast-iron mains is a diameter of about 4 ft., even when the pressure is less than 100 lbs. It is evident that a pipe of wrought iron or mild steel can be safely made of almost any desired size, and this may be of much advantage, if it be desired to conduct a large supply of water through pipes for city or other use. For instance, with an inclination of 3 ft. per mile a single pipe 8½ ft. in diameter will carry 280 cubic feet per second, while seven pipes, each 4 ft. in diameter, would be required to transport the same quantity of water with the same inclination. The cost of the large pipe, made of steel or wrought iron, would be considerably less than one-half the cost of the seven small pipes made of cast iron.

"The ideal conduit for high pressures is a welded steel tube ; such tubes could probably be subjected to a tensile strain of 25,000 lbs. with perfect safety, and would be much preferable to riveted pipe, not only on account of superior strength, but also by reason of almost perfect interior smoothness. . . . The adaptation of a superior and cheap metal, such as mild steel, for conduits, will permit the construction of hydraulic works in many parts of the world which now appear to be impracticable, owing to the cost of many of the methods still in use for the transportation of water."

Spirally-welded steel tubes meet all the conditions above described. The industry gives promise of rapid and even phenomenal development, as the cheapness and excellence of the product command for it instant recognition as the most valuable of recent contributions to engineering materials.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer.*)

(*Continued from page* 78.)

VIII.—THE SAXBY & FARMER DUPLEX DETECTOR.

WE know that the locking of switches in place is done by the use of a bolt, which holds the switch-rod in one or the other position, and that the displacement of the lock can be made either by the movement of the lever which changes the switch or by reversing a separate lever.

In the first case—as, for instance, in the Dujour apparatus—the movement of the single lever, which works both the switch and the lock, is divided into three stages : the first simply withdraws the bolt, the second moves the switch-plate, and in the third the bolt is again moved and locks the switch in its new position.

It is objected to this arrangement—and this objection does not apply simply to the Dujour system, but to the principle on which it is based—that only one-third of the movement of the lever is utilized in moving the switch itself, and, besides, that it would not reveal to the signalman any break or interruption in the transmission of the movement. This last objection could be partially removed by furnishing the switch with controlling apparatus, but it is still more serious than the first ; for if the transmission is broken, and if the signalman reverses the lever, believing that the switch keeps the position which he intended to give it, he would then operate the signal levers authorizing the movement of the train in a different direction to that which it would really take, and thus all the guarantees resulting from interlocking would completely disappear.

It is in answer to this objection, which is, perhaps, theoretic, but nevertheless serious, that recourse has been had to separate levers for operating the switch-locks.

In this second system, the lock and the stop which is used to prevent any movement of the switch while a car is passing over it is worked by a special lever which is interlocked with the switch-lever, and also with the levers moving with the signal authorizing the passage of trains over the switch.

In this case the lock may be simple or double-acting.

When we use a simple lock to hold the switch in one of its two positions, we can always arrange the apparatus in such a way that the lock will reveal to the signalman the state of the switch-connection. It is sufficient, for example, that the switch should be locked in its normal position ; we then unlock it only to reverse it when it could not be taken from the point, and if the connection should be broken it will remain in its normal position, which would not prevent a train from passing over it from the heel ; in this movement from the heel the switch-plate would be displaced automatically and the lock thrown in the reverse position exactly as if it had obeyed the movement of the lever and as if the connection were not broken. But when the train which takes the switch has passed and the signalman attempts to restore the switch to its normal position, he will at once see that the connection is broken, because the lock could not enter the slot and would offer resistance to the movement of the lever.

It would be altogether different if we wished to apply the simple lock to a switch which should be locked in the two positions ; in this case the bolt is normally withdrawn, and can only be thrown into place when the switch has reached the end of its course in one or the other direction ; as there is always a slot opposite the bolt, and it could always be thrown even if the connections were broken and the switch had not changed its place.

It is for this reason that an attempt has been made to secure a double-acting lock with alternative movement, in such a way as *to distinguish the locking for the right-hand direction from that for the left hand ;* only the first types tried depended upon the use of vertical levers, which it was necessary to move in one direction or the other.

The new arrangement applied by Saxby & Farmer, and called by them the *Duplex Detector*, avoids this inconvenience, the locking-lever being of the ordinary type, arranged like the others, while by an ingenious arrangement the reverse position given it corresponds, according to the case, to locking for the right-hand or the left-hand track.

This arrangement is applied to a signal cabin, similar to that shown in figs. 14, 15, and 16 (December number, page 558), the special applications being shown in figs. 47, 48, and 49). They consist of an arrangement placed under the cabin by which the movement of the bar operating the lock can be governed by the position of the switch.

In fig. 47 the two bars, K and S, of the switch and of the lock are in their normal situation, the bolt not being thrown. Now, if the signalman wishes to lock the switch in this normal position, he has simply to reverse the locking-lever which moves the bar S. This bar carries on its lower end a yoke or socket, $m\ n$, which grasps the pin l^1 of the bell-crank $l^1\ o^1\ p^1$, to which is attached the connecting-rod T^2 ; consequently, when S is raised the connecting-rod T^2 is moved in the direction shown by the arrow at a. This connection is prolonged beyond the pin P, and is attached to a second lever, $p^2\ o^2\ l^2$, placed in a reversed position from the first, and when the connecting-rod is moved in the direction a, the lever $p^2\ o^2\ l^2$ moves without producing any further effect, since its extremity, p^2, is free.

If it is intended to lock the switch in the opposite position and to return to the normal position, shown in fig. 47, it is necessary to begin by reversing the switch-lever which would draw up the bar K, the lower end of which moves by the bell-crank lever $l^3\ o^3\ p^3$ the connecting-rod T^1 ; it follows that this bar is then moved in the direction c, and the switch-plate is drawn from one position into the opposite one. On the bell-crank $l^3\ o^3\ p^3$ there is mounted at the point i a bar h carrying a lug r in which the extension t of the bar S engages. When the switch is reversed this bell-crank $l^3\ o^3\ p^3$ moves t, and the whole bar K in the direction f in such a way that the fork $m\ n$ leaves the pin l^1 and takes hold of l^2 ; thus the movement of the switch has the effect of changing the mode of action of the connecting-bar of the lock, which, nevertheless, when it is

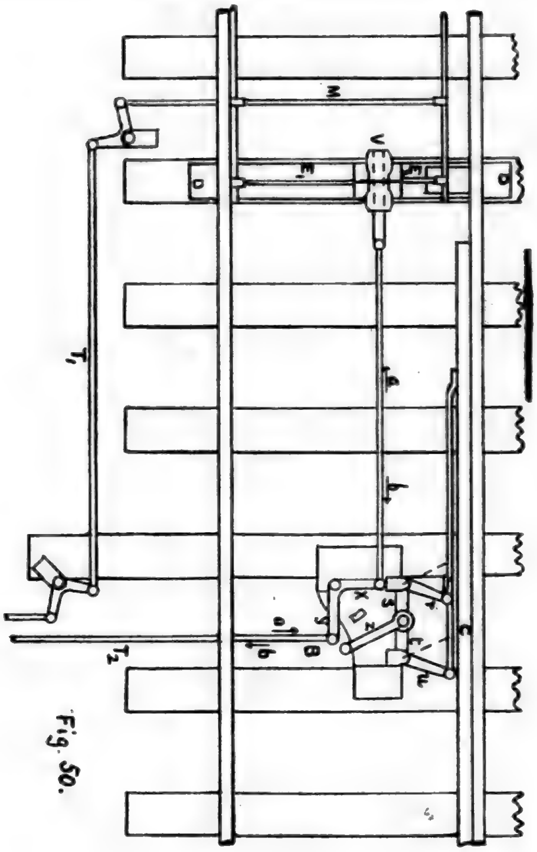


Fig. 50.

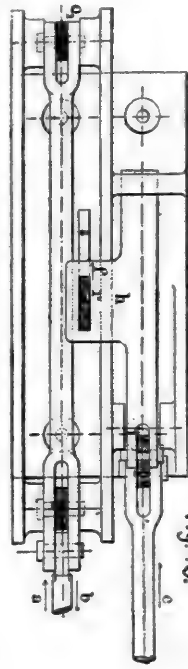


Fig. 48.

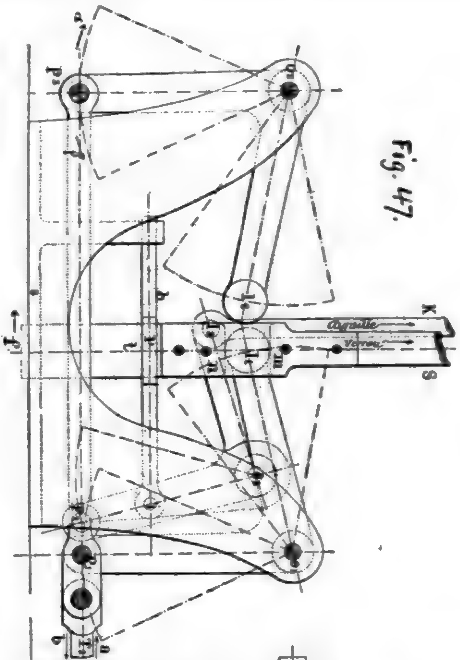


Fig. 47.

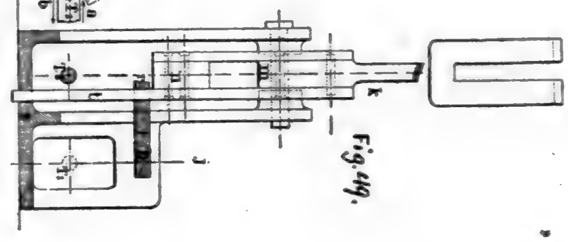


Fig. 49.

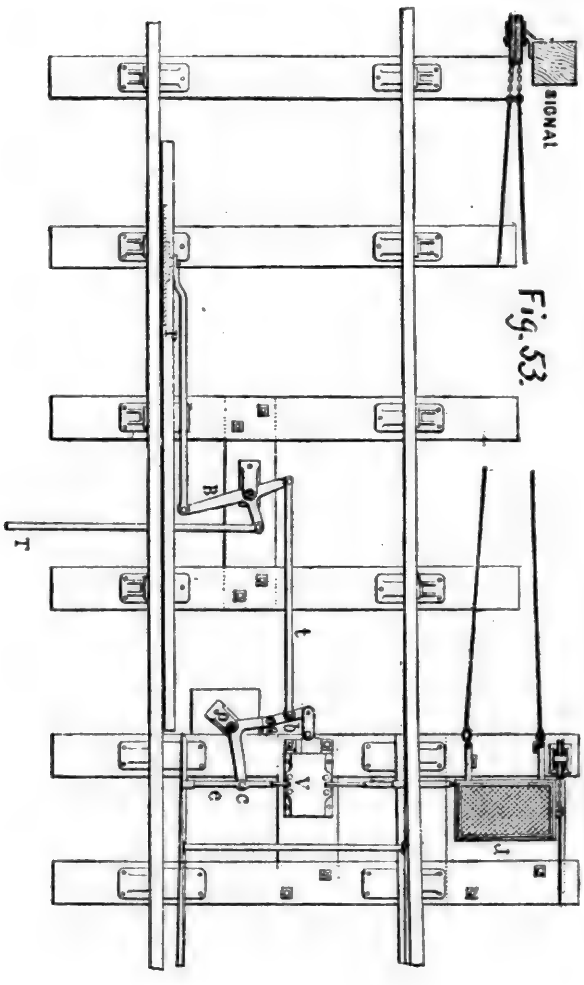


Fig. 53.

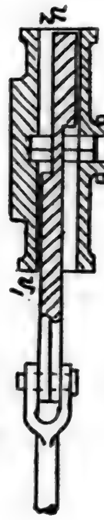


Fig. 51.

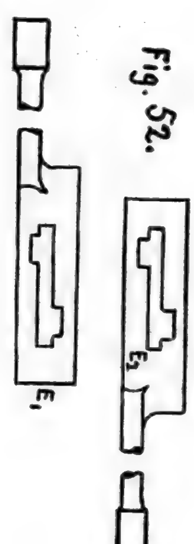


Fig. 52.

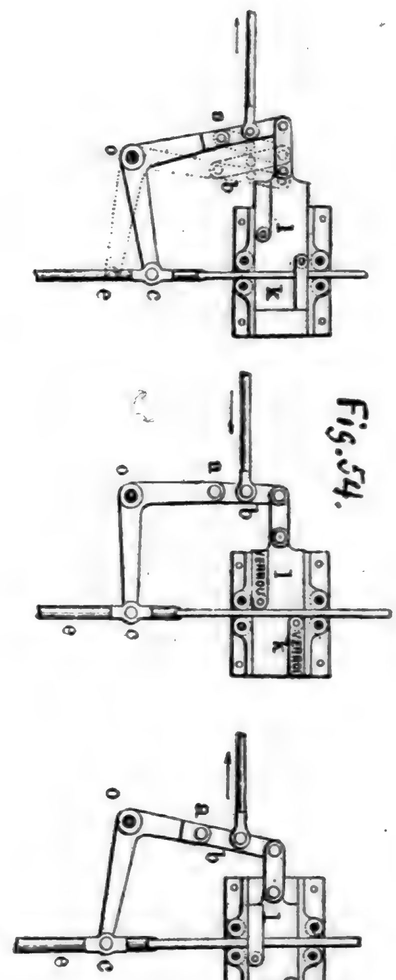


Fig. 54.

moved, in order to lock the switch, will transmit its movement to the bell-crank $l^2\ o^2\ p^2$ in such a way that the displacement of the connecting-rod T^2 will take place in an opposite direction—that is, in the direction *b*, while the movement of the lever $p^1\ o^1\ l^1$ will be without effect because l^1 is free.

By this change of the fork *m n* we thus obtain the movement of the lock connection in one direction or the other, according to the position given the switch. It must be understood that the fork returns to its initial position when we throw back, first the lock-lever and then the switch-lever also.

Fig. 50 shows the arrangement of the locking apparatus and the switch-stop. The connecting-rod T^2 of the switch acts upon the rod *M*, while the connecting-rod T^2 of the lock works the lever *x y*, which moves around the axis *e*; the arm *x* moves the lock in either direction according to

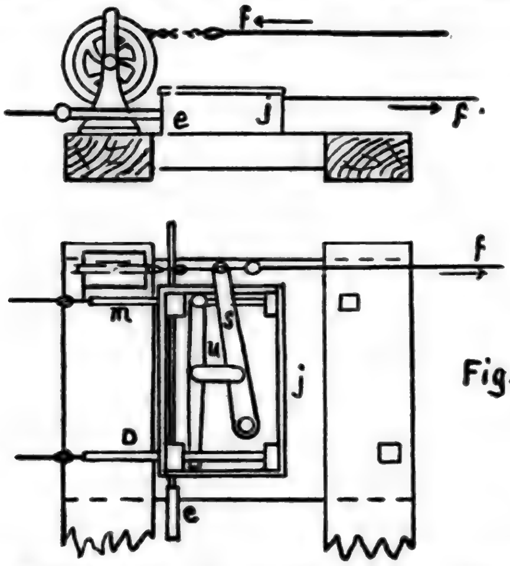


Fig. 55.

the position which the switch occupies, while the arm *y* acts through the rod *z* upon the parallelogram *r s t u* to throw back the stop *C* during the movement of the locking lever, and to restore it to place when that lever has finished its movement.

In order that the movement of *C* may be the same, no matter in which direction the connecting-rod T^2 is moved, the side *s t* of the parallelogram is cut in two around the axis *w* in such a way that, if the movement is in the direction *a*, it is the lever *r s* which turns upon the axis *w* and which moves *C*, but if, on the other hand, the movement is in the direction *b*, the axis *w* draws the lock *t u*, which is moved in the opposite direction from *r s* in such a way that *C* will work in the same manner.

As shown by the section of the lock, fig. 51, there are two parts; the lower one, v^1, enters into the slot of the cross-piece $E^1\ E^2$, fig. 50, when the movement is in the direction *a*; the upper one, v^2, corresponds to a movement in the direction *b*, while between the two there is a neutral position, which permits the movement of the switch-plate. As to the slot, it is composed of two parts, $E^1\ E^2$, shown in fig. 52, which are independent of each other, each one ending in a plate carrying similar slots. In order to produce the locking, it is necessary that these plates shall exactly cover each other—that is to say, that the two plates shall be always in the proper position, and the least disarrangement will be followed by a slight change in position, and the locking cannot be produced.

It must be admitted that this arrangement which we have described gives complete security, for it is hardly to be supposed that the connection of the lock would be broken at the same time as that of the switch. But as the double-acting lock requires a special lever, and the apparatus is somewhat costly and complicated, there are many instances in which we may use the switch-lock with a single lever, and the types which we are about to describe below are very frequently employed.

IX.—THE SAXBY & FARMER SWITCH-LOCK.

This lock is based on the same principle as that of M. Dujour, except that the locking arrangement is placed between the tracks and upon the switch-plate itself, which gives more security by doing away with the chances of disarrangement, which could be produced in the Dujour apparatus in the connection between the bolt and the switch-plate. Moreover, a special mechanism adjoining the switch permits the working of a signal of any form which may be preferred, and the giving it by a special lever a proper position in relation to that of the switch.

The advantage of this arrangement is that it can be applied, even where there are no interlocking systems, the signal and the switch-lock each having separate levers, not placed side by side.

As shown in fig. 53, the single connecting-rod *T* works, through the lever *B* on one side the switch-stop *P*, and on the other the bar *t*, joined to a lever, *a*, the latter being united on one side to the bell-crank lever *a o c*, which works the switch-bar *e*, and on the other to the lock-plate *V*. Fig. 54 shows this arrangement on a larger scale, with the levers in three different positions.

In the first part of the movement the bar is unlocked; in the second the lock *k* being drawn out of its slot, and the bolt *l* bearing against the bar *e*, the lever *a o c* causes the bar to move in such a way that the slot is presented before the bolt *l* which can then enter it; and as the switch-plates offer resistance the rest of the course of the connecting-rod is utilized to throw *l* into the slot and to lock the switch in its reversed position.

The bar *e* is extended beyond the track into a covered box, *j*, the arrangement of which is shown in fig. 55.

The double wire connection *f* (fig. 55), worked by the signal-lever, is attached to a lever *s* which acts upon the lever *u*; this last lever acts by one or the other extremity, according to the position of the switch, because one of the bars, *m n*, bears against the bar *e*, while the other enters a slot made for the purpose in this bar. It follows that it is the signal for the right-hand or the left-hand track which is moved by the lever, as may be required, an agreement being established by this arrangement between the signal and the direction given to the switch.

This system is applied chiefly to the point switches furnished, according to the English plan—used also on the Paris, Lyons & Mediterranean system in France—with semaphores which are absolute stop-signals, having two arms which are normally in a horizontal position. To authorize the passage of a train the upper arm must be lowered for the left-hand and the lower one for the right-hand track. With the arrangement shown, this result can be obtained with a single lever, and the change of signals is made by the connection between the switch and the bar.

(TO BE CONTINUED.)

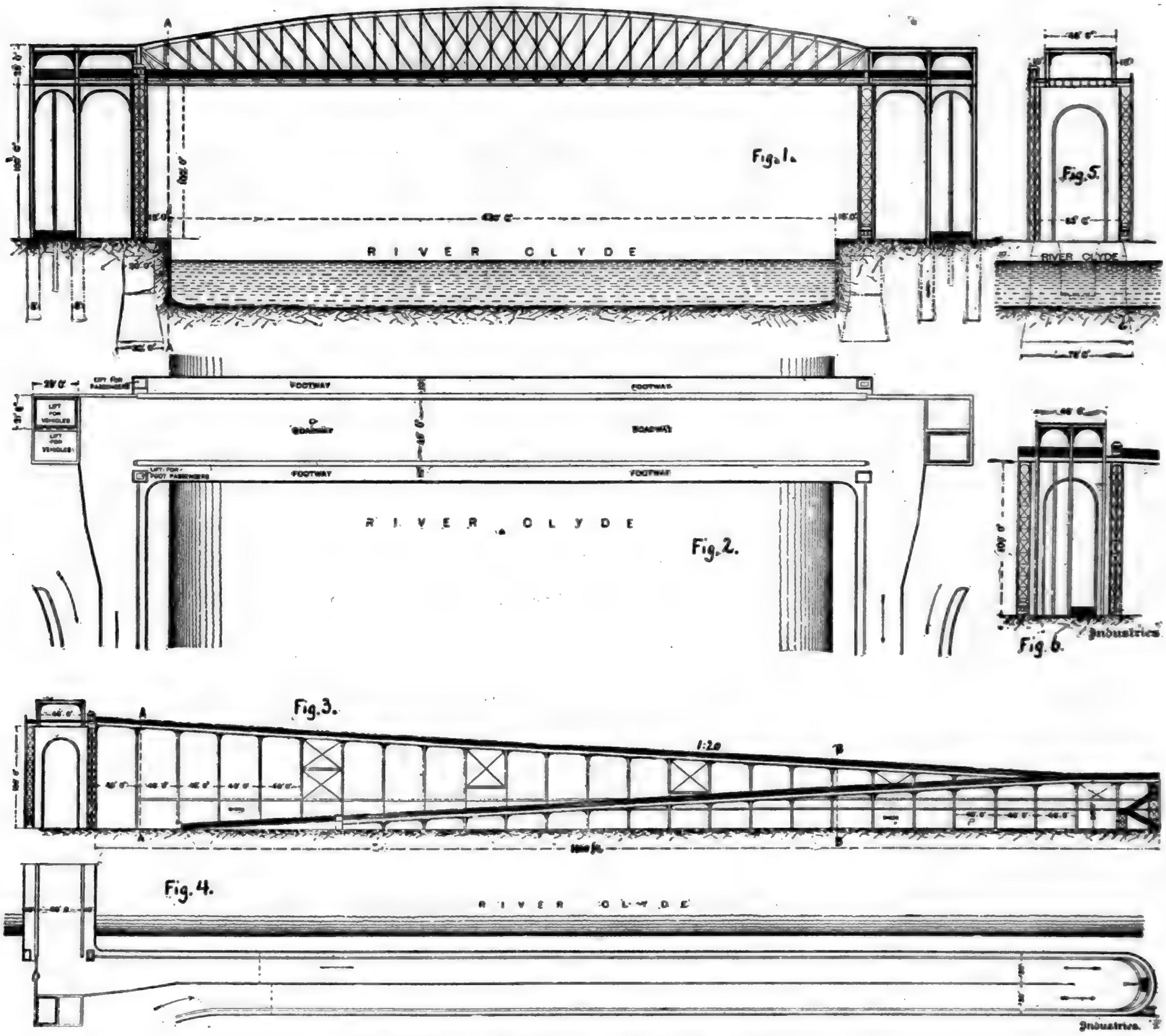
PROPOSED BRIDGE OVER THE CLYDE.

(From *Industries*.)

CROSS-RIVER communication, in cases where the rivers are used as harbors, and where the passage of steamers of considerable size has to be provided for, has been felt to be a serious difficulty in nearly all of our great ports. The Thames, the Tyne, and the Wear, with large populations on either bank, have all been bridged for large craft within their respective harbors. In the Clyde, however, the first bridge which one encounters, in sailing up the river, practically limits the harbor to the reaches of the river below it. There are a great number of cross-river ferries—swift and handy little steamers, and carrying a number of passengers quite sufficient to cope with a very large cross-river traffic. These ferries run continuously, so that there is no break in the continuity of the service. But, with the exception of the ferry at Pointhouse, they are exclusively devoted to the use of foot passengers. There is thus a distance of two miles between the bridge at one end of the harbor, and the horse ferry at the other. The inconvenience thus caused is so considerable, that for some years indefinite proposals have been made from time to time as to the expediency of providing some more convenient method of transit across the river.

A proposal of a definite character for the construction of a bridge over the Clyde at Finnieston has been made by

Mr. William Arrol, Contractor for the Forth Bridge, and has been placed before the Clyde Trustees. Among the questions involved is, of course, the question as to who should bear the cost of such a bridge; but the interests of the Clyde Trustees in transit upon the Clyde is so great that the matter in its initial stage will at least be seriously considered by them, with a view to its erection. Mr. Arrol proposes the construction of a bridge from the north side to a point on the south side, a little to the east of the present Finnieston Ferry. The bridge would consist of a single span of 430 ft., and the roadway would be at a level of 100 ft. above the top of the quay wall, so that the largest vessels proceeding to berths in the upper reaches of the provided two sets of hydraulic lifts. One of these sets would be used for passengers, and the other set for carts. The special feature of the design is that it affords advantages over both a swing bridge and a tunnel. In the first case traffic would be intermittent, and therefore conducted under disadvantages similar to those which already exist. In the second case, while an alteration of level, and therefore prolonged inclines, with hydraulic appliances, would be necessary, there would be the additional trouble and cost of lighting the tunnel. As against both a swing bridge and a subway, it is calculated that the proposed high level bridge would be much cheaper, both in first cost and in maintenance; indeed, the estimate for its construction is



PROPOSED BRIDGE OVER THE CLYDE.

DESIGNED BY WILLIAM ARROL, ENGINEER.

harbor would have to lower their topmasts to clear the bridge. The roadway would be 40 ft. broad, and there would be a footpath 10 ft. wide on either side. Since the ground on each side of the river stretches back for a great distance at a level almost the same as that of the top of the quay wall, no assistance can be had from a natural gradient. Access to the bridge is therefore obtained by an inclined plane on either side, doubling upon itself, and supported almost throughout its whole length upon steel columns. With the exception of some brick-work at the lower end of the incline, the whole structure would be of steel. In addition to this roadway thus approached by an incline 2,000 ft. long, with a gradient of 1 in 20, there would be roughly set down at £150,000. The expedient of making the incline return upon itself effects a considerable saving in ground, especially since the columns which support the inclined roadway will form an integral part of the quay sheds, which will, as now, occupy the ground. The only serious objection to the scheme is the height required, 100 ft., and the steepness of the gradient necessary to reach it. The scheme is an interesting one, and deserves thoughtful consideration.

In the accompanying illustrations, fig. 1 is an elevation of the bridge; fig. 2 is a plan; fig. 3 is an elevation, and fig. 4 a plan of the approaches, while figs. 5 and 6 are sections at different points.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page 66.*)

CHAPTER XXXV.

THE THWAITES DOUBLE-ACTING HAMMER.

THE firm of Thwaites Brothers, in Bradford, England, build hammers of different types, varying according to the work which they have to do. The type represented in fig. 14 is especially intended for the use of steel-works, for forging and drawing out ingots ; it is widely used in England, five being at work in the mills of the Landore-Siemens Steel Company, while others are in use by the Steel Company of Scotland, by the West Cumberland Iron & Steel Company, and by Brown, Bayley & Dixon in Sheffield. Recently two of these hammers, of 15 tons each, have been delivered to the Union Company at Dortmund, in Westphalia. The dimensions of these hammers are as follows : Diameter of steam cylinder, 1.060 meters ; stroke of the hammer, 2.745 meters ; distance between the pillars, 5.000 meters ; clear height under the frame, 2.360 meters.

This type of hammer, the power of which varies from 8 to 15 tons, is composed of two pillars, or hollow rectangular columns, built up of plates and angle-bars, and joined at the top by cast-iron guides upon which the steam cylinder is fixed.

These hammers are constructed with great care ; all the plates and angle-bars are carefully fitted, the rivet holes are drilled and not punched. For hammers of less weight, the makers also use pillars of a circular form, and these are employed in forging tires and wheels.

The Cockerill Company has built for the Northeastern Steel Works at Valenciennes, France, two hammers of a type similar to the last, one being of 10 tons and the other of 15 tons.

This arrangement, when the pillars are set well apart, gives the hammerman an opportunity of working very freely around the anvil. It may be noted also that the 50-ton hammer at Perm, Russia, is of the same type of construction.

For hammers intended exclusively for forging, MM. Thwaites use also the arrangements shown in figs. 15 and 16 ; these hammers, one of 5 tons and the other of 10 tons, have been made for the Wendel Forge at Hayange ; the John Brown Works at Sheffield also have several 20-ton hammers of similar type.

In all, the double-acting hammers built by Thwaites Brothers, the ratio between the weight of the striking mass alone—without counting the steam pressure acting upon the piston—and the weight of the anvil-block, is 1 : 10. We believe that this ratio is too small, and that it should not be less than 1 : 12.

In these hammers steam is distributed by means of a circular balanced valve, similar to the method shown in figs. 29, 30, and 31.

The section of the steam ports is made as shown in fig. 118, the bars separating the openings having a width equal to one-third of the opening, so that if we suppose the steam to pass through with the same speed as before and the height of the openings to be $h = \frac{1}{9} D$, we have

$$3.14\, D \times \frac{1}{9} D = \frac{4}{3} S \therefore D = \sqrt{3.82\, S}.$$

Fig. 29

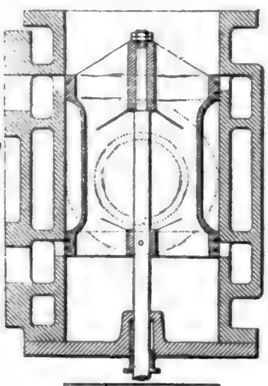


Fig. 30

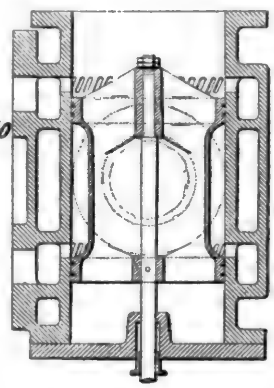
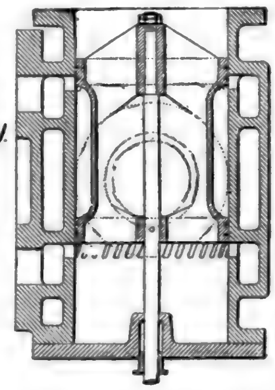


Fig. 31.



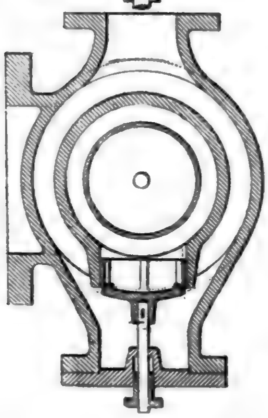
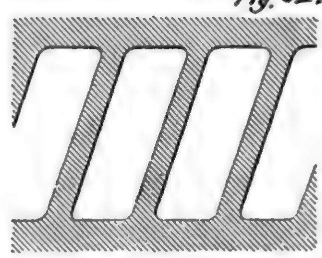


Fig. 32.



Here h is the height of the opening ; D is the diameter of the circular valve, and S is the area of the exhaust valve of a hammer of the same force.

In the 50-ton hammer at the Obookoff Works in Russia, which was built by Thwaites Brothers, the diameter of the valve has been increased to 0.762 meter, and the height to 0.088 meter, instead of the dimensions of 0.606 and 0.067, which would be given by the formula above. This indicates that with this hammer the object has been to make it possible to run at a low pressure, and to obtain, in spite of that, an almost instantaneous exhaust, in such a way as to avoid all counter-pressure and to facilitate the fall of the hammer.

Fig. 118.

All these hammers have been so built that they can be used, if desired, as single-acting hammers ; for that purpose all that is necessary is to diminish the travel of the circular valve in such a way that it will not uncover the port admitting steam to the cylinder above the piston.

To raise the hammer to its full stroke the valve should be moved until it occupies the position shown in fig. 30,

when steam enters under the piston and raises the hammer, while the upper part of the cylinder is in communication with the exhaust. To permit the hammer to descend the piston should be moved until it occupies the position shown in fig. 31, when the steam acts upon the upper side of the piston, and the lower part of the cylinder in its turn

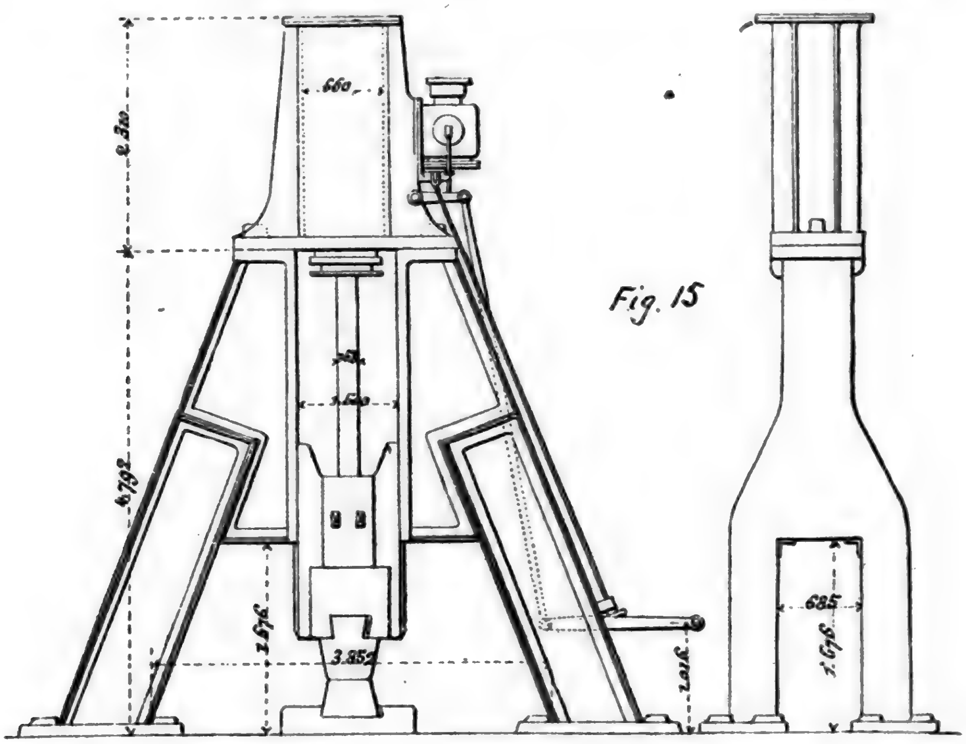
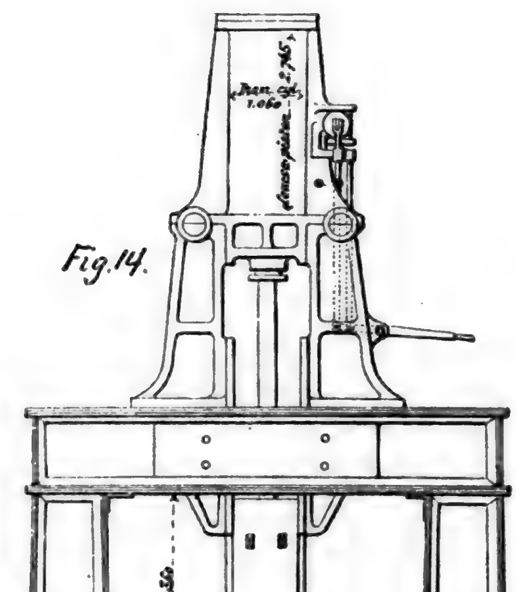


Fig. 15

Fig. 14.



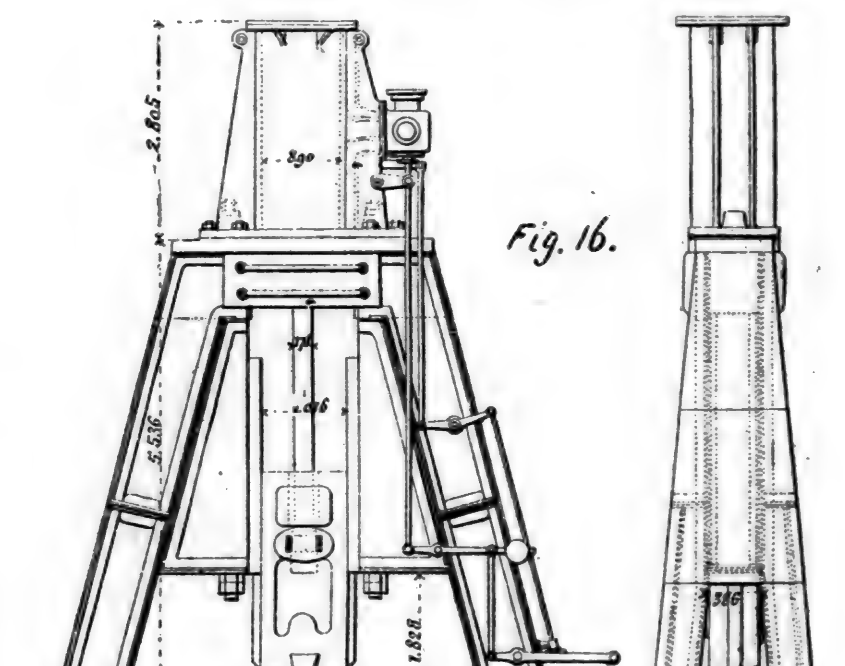


Fig. 16.

communicates with the exhaust. When the valve occupies the position shown in fig. 29 the hammer is at rest, and steam cannot enter the cylinder or act upon either face of the piston.

The general custom is to open the port wide when the steam acts on the lower face of the piston, raising the hammer, and to give only a half opening when the steam acts upon the upper face of the piston.

All hammers used for making large forgings have the valves worked by hand.

CHAPTER XXXVI.

GENERAL REMARKS ON DOUBLE-ACTING HAMMERS.

Hammers up to 500 kilogrammes should be so made as to work either automatically or by hand; for small hammers, used to forge pieces requiring rapid and uniform blows, the automatic working is very useful, but for more powerful hammers, in which the changing or moving of the pieces on the anvil requires a certain time, and which, consequently, are not required to act very swiftly, the hand working is sufficient, and the automatic working can be dispensed with.

Quickness of movement is especially desirable in working steel and in forging small pieces, which ought to be drawn into shape at a single heat.

In automatic hammers the admission of steam to raise

the hammer should always be regulated in such a way that it never precedes the blow; if not, there will be a thin cushion of steam which will produce counter-pressure, and will take away something from the force of the blow. It is necessary, in fact, that there should be a slight delay in the admission of steam, so that the blow may produce its full effect.

Hammers should be arranged in such a way that they themselves will determine the upper end of the stroke, and will by their own motion stop the ascending stroke; this is, in fact, an indispensable precaution, if we wish to utilize the full effect of the fall of the striking mass, without being subject to the possibility of accidents.

In double-acting hammers we can at any moment modify by hand, or even suppress entirely, the automatic motion; in the same way we ought to be able to make the force of the blow entirely independent of the speed, in such a way, for example, that the hammer can be run at the maximum speed of which it is capable, while at the same time we can give a light or heavy blow at will, according to the nature of the work which is being done.

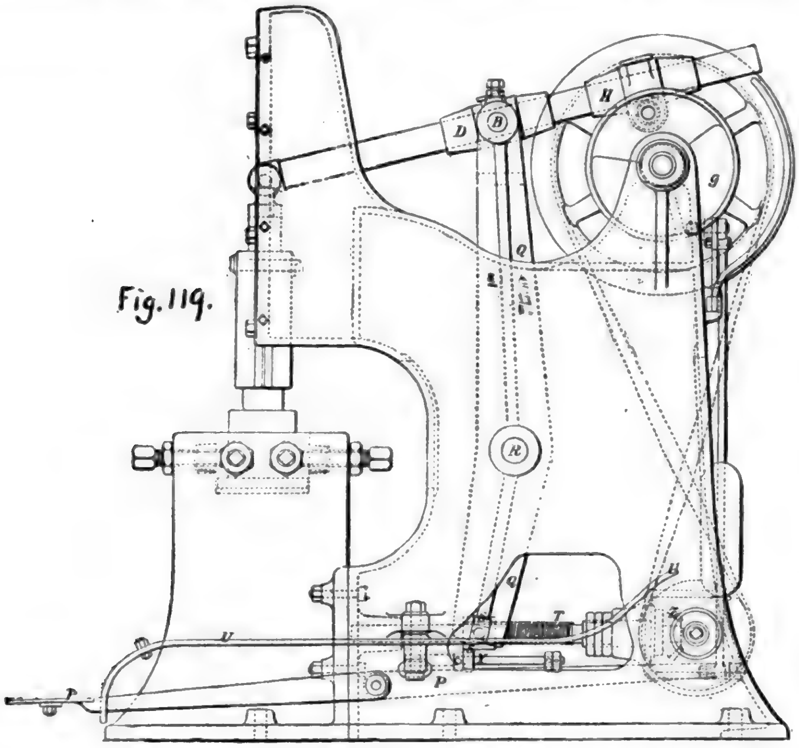


Fig. 119.

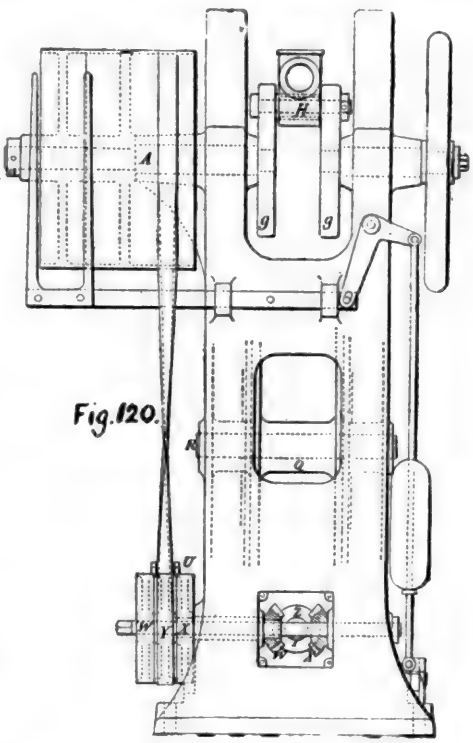


Fig. 120.

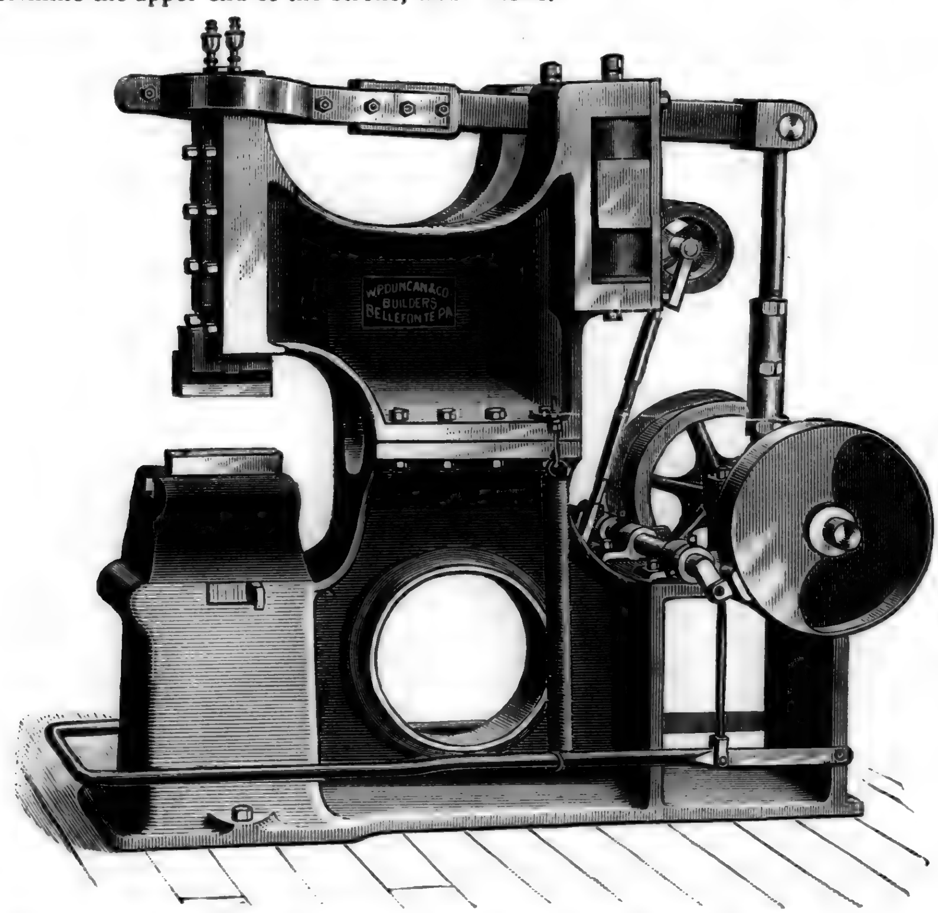


Fig. 121.

The use of steam, which is very small in comparison to the work done under ordinary conditions, becomes much greater when we are not able to utliize the force of the fall of the hammer—that is, of gravity; this results from the

large space above the piston, and which is filled usually with steam at each blow.

In the construction of these hammers we should always seek to realize the conditions given below.

1. Solidity in all the parts composing the machine.
2. To keep down the number of parts as small as possible, and to give them simple forms.
3. To make the hammer so that parts can easily be replaced in case of wear or breakage.
4. To give the anvil-block a weight equal to 12 or 15 times that of the striking mass.

Under favorable conditions these double-acting hammers are economical in one respect, as a hammerman can do two or three times as much work as without this tool. They also produce economy in fuel, as compared with hand-forging, as fewer heats are required ; moreover, pieces forged under the hammer are much more exact and nearer the proper dimensions than those forged by hand, so that the expense for fitting and finishing such forgings is much less.

CHAPTER XXXVII.

THE PLAYER SPRING HAMMER.

Figs. 119 and 120 show a helve-hammer constructed by W. & J. Player, of Birmingham, England, and intended for making die-forgings, swaging and tilting bars, plating edge-tools, and similar work. In a hammer of the size shown the hammer-head itself weighs 112 lbs. ; the stroke varies from 4 in. to 14 in., and it can be run up as high as 200 blows per minute ; the compressed-air space between the main piston and the hammer-head is sufficiently long to admit forgings up to 3 in. in thickness.

The operations of starting, stopping, and regulating the blow are completely under the control of the workman through his foot, which is placed upon the lever *P*. The movable fulcrum *B*, figs. 119 and 120, consists of two adjustable steel pins attached to the fulcrum lever *Q*, and turned conical where they fit in the socket *D*.

The fulcrum lever is pivoted on a pin *R* fixed in the framing of the machine, and is connected at its lower extremity to the nut *S* in gear with the regulating screw *T*.

The to-and-fro movement of the fulcrum lever *Q*, by which heavy or light blows are given by the hammer, is placed under the control of the foot of the workman, in the following manner : *U* is a double-ended forked lever pivoted in the center, and having one end embracing the starting pedal *P*, and the other end the small belt, which connects the fast pulley on the driving shaft *A* with the loose pulley *Y* or the reversing pulleys *W* and *X*.

These are respectively connected with the lever wheels *W* and *X*, gearing into and placed at opposite sides of the bevel wheel *Z*, on the regulating screw in connection with the fulcrum lever. When the workman places his foot on the pedal *P* to start the hammer, he finds his foot within the fork of the lever *U*, and by slightly turning his foot round on his heel he can readily move the forked lever to right or left, so shifting the small belt on to either of the reversing pulleys *W* and *X*, and causing the regulating screw *T* to revolve in either direction.

The fulcrum lever is thus caused to move backward and forward to give light or heavy blows.

By moving the forked lever into mid-position, the small belt is shifted into its usual place on the loose pulley *Y*, and the fulcrum remains at rest.

To fix the lightest and heaviest blows required for each kind of work, adjustable stops are provided, and are mounted on a rod *V* connected to an arm of the forked lever.

When the nut of the regulating screw comes in contact with either of the stops, the forked lever is forced into mid-position, in spite of the pressure of the foot of the workman, and thus further movement of the fulcrum lever, in the direction which it was taking, is prevented.

The movable fulcrum can also be adjusted by hand to any required blow, when the hammer is stopped, by means of a handle in connection with the regulating screw.

CHAPTER XXXVIII.

THE DUNCAN HELVE-HAMMER.

Fig. 121 shows the Duncan helve-hammer, made by the firm of Jenkins & Lingle, at Bellefonte, Pa. Fig. 121 is a general view of the hammer, while fig. 122 shows another view of the helve.

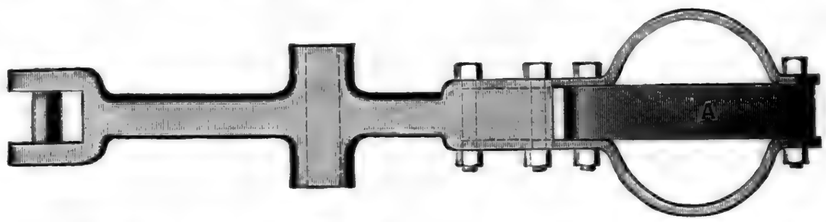


Fig. 122.

In this hammer, which is intended for die-forging, working small pieces and similar purposes—very much the same as the Player hammer above described—the main portion consists of a cast-iron frame of neat and substantial form, carrying an anvil-block sufficiently heavy to take up the force of the blow. By means of the treadle, shown in the engraving, the blow can be regulated to any desired strength, up to the full capacity of the ram. The ram, or hammer-head, being held in vertical slides, always strikes in the same place, making it desirable for die-forging. The blow is cushioned by means of four rubber cushions, two placed below and two above the fulcrum bearing of the helve ; this fulcrum is made in the form of a crosshead, to which the helve is pivoted ; this crosshead being free to move up or down as the strain comes on the helve.

The tension of these cushions can be regulated by means of bolts passing through them. The ram is connected to the helve by means of a flexible strap of leather passing through a bolt in its upper end, and is connected at either end to pins passing through two semicircular pieces of flat spring steel, these being bolted to the helve, as shown in fig. 122.

The force of the blow is controlled through the stress pulley, which is operated on through the treadle. The hammer is run by a belt, and is an exceedingly useful tool for small forgings and die-work.

(TO BE CONTINUED.)

A FOUR-CYLINDER COMPOUND LOCOMOTIVE.

(Condensed from Memoir of M. du Bousquet in the *Revue Generale des Chemins de Fer.*)

SOME time since M. G. du Bousquet, Engineer and Inspector-General of Motive Power of the Northern Railroad of France, was commissioned to make some experiments with the compound locomotive. For this purpose it was decided to adopt the Woolf system, with four cylinders, the cylinders arranged in pairs, or tandem, as it is called. The locomotive selected for the trial was one of those used for working the coal traffic of the road, having four driving-wheels coupled, with the entire weight upon those wheels. The dimensions of this engine before alteration were as follows :

Diameter of cylinders	0.500 meter.
Stroke	0.650 meter.
Diameter of driving-wheels	1.300 meters.
Total weight of engine	44.700 tons.
Grate surface	2.08 sq. meters.
Heating surface, fire-box	9.20 sq. meters.
Heating surface, tubes	116.78 sq. meters.
Heating surface, total	125.98 sq. meters.

The alterations, which were made in the shops of the Company at Hellemmes, consisted in the substitution of new cylinders for the old ones, with the necessary modifi-

cations in the guides and valve motion. In consequence of the greater length of the cylinder casting for the compound cylinder a slight lengthening of the frame is necessary, 0.545 meter being the addition. The compound cylinders—high and low pressure—were cast in a single piece, the intermediate head being riveted in. The small cylinder projecting backward beyond the tire of the first wheel, it was necessary to cut the cylinder-head at the side, as shown in the accompanying illustrations.

In these drawings fig. 1 is a section of the cylinders and steam-chest ; fig. 2 a side view or elevation of the cylinder casting ; figs. 3 and 4 show the crosshead ; fig. 5 is a view

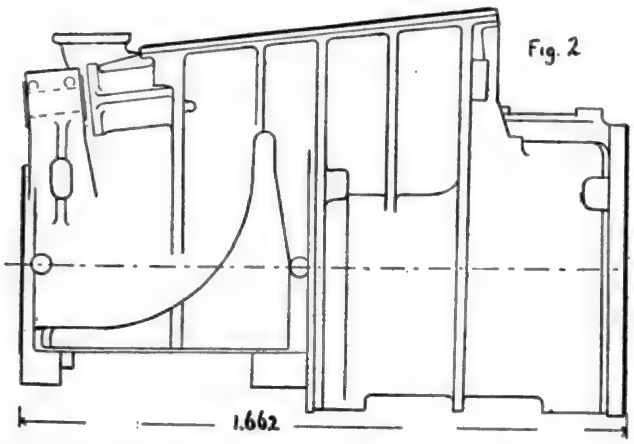


Fig. 2

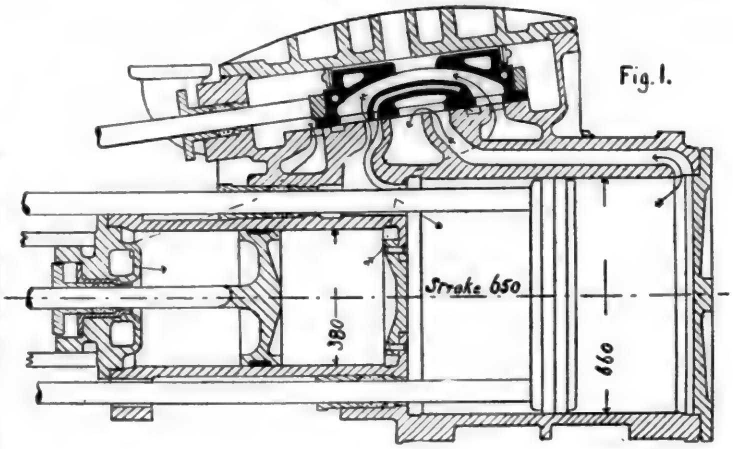


Fig. 1.

of the back cylinder head, showing the arrangement of the guides and the stuffing boxes, while fig. 6 is a sketch of the locomotive, showing its general arrangement. The valve gear used is the link motion with the solid link, which is very commonly used in France.

The steam-chest is placed above the two cylinders, as shown in fig. 1 ; there is a single valve moving on a valve face having five ports. The two outside ports communicate with the high-pressure or small cylinder ; the two intermediate with the low-pressure or large cylinder, while the central port is the exhaust. The exhaust port is in the

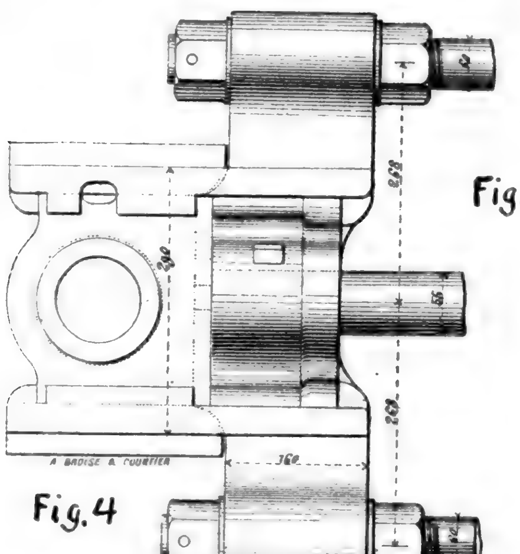


Fig. 4

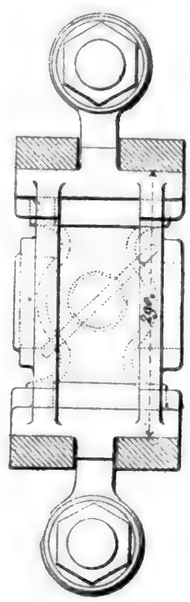


Fig. 3.

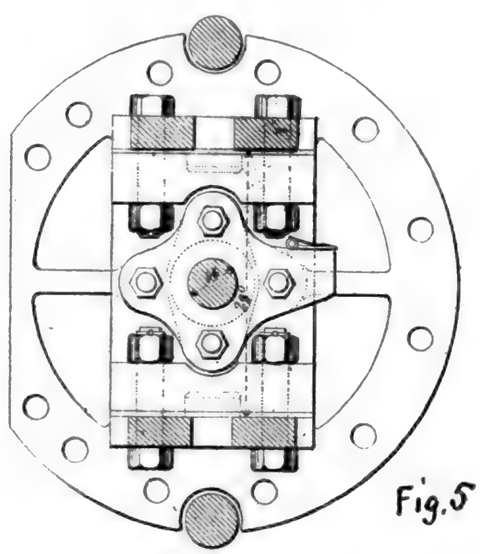


Fig. 5

same position with relation to the frame as that of the old cylinder.

The valve is made with a second passage, as shown in fig. 1, through which the exhaust from the small cylinder passes into the large cylinder at one end or the other, according to the position of the valve. This passage is, in fact, the intermediate reservoir for the steam. Its area is 16.5 per cent. of that of the small cylinder.

The passages which conduct the steam from the valve-chest to the small cylinder are longer than usual, and in this way the necessary enlargement of the free spaces of that cylinder is obtained by the position of the steam-chest ; they have, in fact, been increased to 16.4 per cent. of its area. The two useless spaces of the large cylinder can thus be made very small ; the back space is small in any event, while the forward space can be diminished by moving the steam-chest slightly forward of the center. In this engine the area of these spaces was 7 per cent. of that of the cylinder.

The size adopted for the compound cylinders was 0.380 meter diameter for the small, and 0.660 meter for the large cylinder, the stroke remaining 0.650 meter. The ports of both cylinders have the same length, 0.044 meter. A small opening of the valve gives a sufficient area for the admission of steam to the small cylinder, while for the large cylinder the valve adopted gives really a double opening.

The valve, which is of bronze, has a rectangular form on the face, but above it is cylindrical, and a groove turned in the cylindrical part receives two segments of cast iron. A ring of cast iron carefully bored out is placed upon these segments which form a sort of piston ; this piston is held in place by the pressure of steam and by four springs which are placed on the upper surface of the rings, which, while leaving it free to turn, give it a constant bearing against the steam-chest cover. The pressure of the steam contained in the steam chest is then only felt on the rectangular surface of the base of the valve, which is diminished, of course, by the interior surface of the ring, which is 0 480 meter in diameter. Pressure on the valve is thus very light, and is, in fact, insufficient to hold it in place when the central part is in communication, as in an ordinary valve, with the air. For this reason it was found desirable to put this part in communication with the steam held in the intermediate passage by drilling a small hole in the upper part. In practice it was found that, in spite of the large dimensions of the valve—0.605 × 0.520 meter—the friction between the valve and the valve-seat could be diminished as

much as desired. It may be noted that any slight leakage of steam around the ring would be of no importance, as the steam would pass directly into the large cylinder.

The piston of the large cylinder is of cast iron, with the ordinary packing rings, and has two rods placed far enough apart to pass one on each side of the small cylinder. In this way any use of interior stuffing-boxes is avoided.

The small piston is of wrought iron forged in one piece with the rod. The three rods are connected with the same crosshead, which is of cast steel ; the central rod—that of the small cylinder—being held by a key, the two others fitting in taper holes and held in place by two nuts, as shown in figs. 3 and 4.

The guides, which are of steel, are made double on account of the form of the crosshead, so as to permit the arms to which the two piston rods of the large cylinder are attached to pass through them. They are supported at the back end by a yoke or brace in the ordinary way, and at the front end are bolted to lugs cast on the back cylinder head, as shown in fig. 5.

It will be seen that when it is necessary to take down the pistons, that of the small cylinder must be taken out from the back, and that of the large cylinder from the front.

In this arrangement it will be seen that the breakage of the intermediate head would have serious consequences. Such a breakage might be produced by the breaking of the small piston-rod or by the breaking of the connecting-rod. In order to avoid the first case, it is important to make the piston-rod large enough ; it may also be remarked that even if it should break, the small piston would not strike the cylinder head with the same force as in an ordinary locomotive, first because the counter-pressure is considerable, and, second, because the steam exhausts into the confined space of the large cylinder, and not freely into the air. The second case is more to be feared, but the remedy is easy : it is to leave more clearance before the small piston at the end of its stroke than before the large one ; the large piston would then strike first and the front head of the cylinder would receive the main shock. It is also possible to adopt an arrangement by which the crosshead would strike the end of the guides before the piston would strike the head.

The exhaust used is the ordinary variable exhaust employed on this class of engines. The only change is that the blast-pipe is somewhat larger, the section having been increased from 229 to 308 sq. cm., the steam being more expanded and requiring a greater space ; moreover, the right and left-hand exhaust are separated by a partition which is carried up nearly to the head of the blast-pipe. This arrangement has been found to work very well, and steam-pressure is easily kept up in the boiler, even during long stops.

It may be noted that in order to diminish resistance when steam was shut off while the locomotive was in motion, to avoid heating and to prevent the drawing of gas and cinders into the cylinders, a small valve was placed on the steam-chest cover by which air could be admitted. This was easily worked, and was found to give very good results.

The increased weight of the new cylinders threw too great a proportion of the weight on the forward drivers ; this was remedied by using a heavy cast-iron foot-plate at the rear of the engine ; this weighed 3,000 kilos. The total weight of the machine was increased by 7,000 kilos., its weight after alteration being 51.700 tons.

The weight of the engine and its distribution, before and after alteration, was as follows in tons :

	As Altered.	Old Weight.
On first pair of drivers	13.460	12.200
On second pair of drivers	14.240	11.100
On third pair of drivers	13.980	12.100
On fourth pair of drivers	10.020	9.300
Total, tons	51.700	44.700

A special steam-valve 3 cm. in diameter, placed behind the throttle-valve, permits steam to be admitted directly into the large cylinder. The pipe which conducts steam from this valve passes through the center of the valve-seat and communicates with the passage which forms the reservoir between the two cylinders. In this way steam can, if desired, be admitted directly to the large cylinders, but in practice this is not found necessary either in switching or in ordinary running on heavy grades ; it would be, moreover, unfavorable to the proper utilization of the expansive force of the steam.

This special admission of steam, however, is useful in case of a chance stoppage on a heavy grade, as it permits the starting of the train with all couplings in tension, and without a jerk. It will be seen that under these conditions breakages of couplings are much less to be feared.

Each double cylinder is furnished with four cylinder-cocks to discharge condensed water, the same as in an ordinary cylinder.

It is important in compound engines to take some precautions to avoid a useless waste of oil. In the engine described the only additional lubrication required was for the piston of the large cylinders. For this purpose the Consolin oiler was used, by which the steam is charged with oil on its passage from the valve, no attempt being made to lubricate the parts separately.

The first trials of this engine were made upon the main line of the road, where it was put into service hauling coal trains, and where its work was compared with that of other engines of the same class with the ordinary simple cylinders. The usual load of these trains was 675 tons, or 45 coal cars ; with the compound engine this load was in-

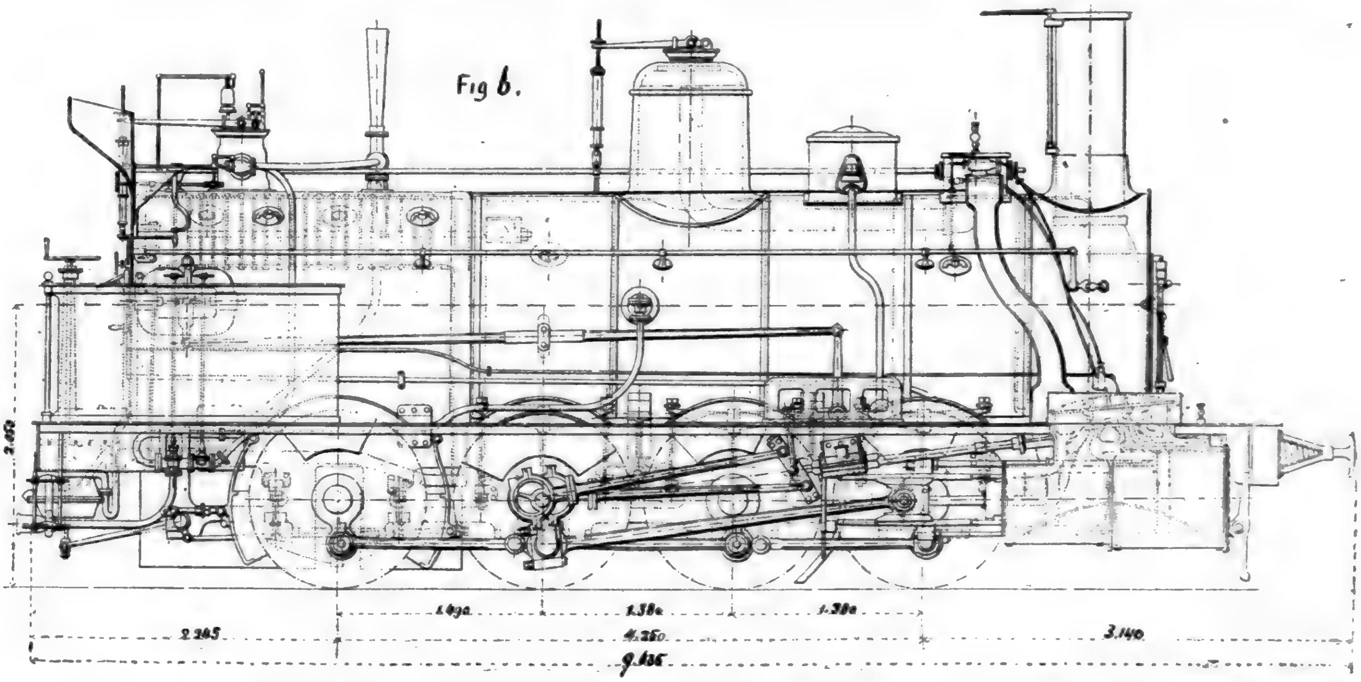


Fig 6.

creased to 60 cars or 900 tons. The trip made was from Lens to Longueau, and return, 170 kilometers. This trial was made during the month of January, when the conditions are usually most unfavorable to traction. The starting from Lens was always made without trouble, although somewhat difficult, since the start from the yard tracks is on a grade of 1 per cent., and over a very sharp curve, and a train enters immediately upon a grade of 0.5 per cent., 10 kilometers in length.

On certain trips the engine ran through to La Chapelle; on one of them the load of 900 tons was taken from the station at La Chapelle to the coal switches there over a grade of 1.5 per cent., 600 meters long, at the foot of which the train had to be started. To get over this difficult point it was necessary to use the direct admission of steam to the large cylinders; diagrams taken, however, with this admission showed that, owing to the small opening of the valve, 3 cm., there was not the full boiler pressure upon the large pistons, and that, consequently, the strain upon the working parts was not too great. It was found that the boiler was sufficient to supply all the steam needed.

The officers in charge of the train service considered that it was not advisable to run more than 45 cars to each train on the main line, as they believed it more desirable to increase the speed than the load. For this reason it was determined to make a new series of trials on the branch from Valenciennes to Hirson, on which there are grades varying from 1 to 1.25 per cent., and which has a very irregular profile. The usual train-load on this branch was 422 tons over about one-half of its length, and 387 tons on the remaining half, where the heaviest grades were situated. With the compound engine this load was increased to 540 tons over the whole line.

The following table shows the results obtained in the consumption of fuel on these trials with different loads. The fuel used was generally waste coal containing a large proportion of slack, with enough briquettes (prepared fuel) to maintain a good fire, and it may be noted that the compound engine required a much smaller proportion of the briquettes than the other. The table gives the consumption of fuel per kilometer with different train-loads, No. 4,729 being the compound engine, and No. 4,728 another engine of the same class which has not been altered:

Train-load.	Kilog. burned per Kilom. No. 4,729.	No. 4,728.	Per cent. of Saving.
400 tons	17.3	20.0	13.5
450 tons	26.5	20.0	24.5
500 tons	25.2	19.6	22.4
540 tons	35.2	27.0	23.6

After this series of trials the two engines with which they were made were put, in July 1888, in ordinary service between Fives and Hirson, hauling the same trains on alternate days. The station agents had orders to put a load of 522 tons on the compound engine and 462 tons on the other, these loads being calculated on the limit of adhesion. The table below gives the results obtained in the consumption of fuel per kilometer, No. 4,729 as before being the compound engine, and No. 4,728 the other; this trial was extended over two months, and the results are averaged for each month:

Month.	Kilog. burned per Kilom. No. 4,729.	No. 4,728.	Per cent. of Saving.
July	13.81	15.86	12.9
August	14.18	15.94	11.0

It will be seen that in this case the saving in fuel, in spite of the increase of 13 per cent. in the load, was from 11 to 13 per cent., while the expense of lubrication was less for the compound engine than for the other. If the load be taken into account, the saving in fuel per kilometer-ton was from 27.2 to 21.1 per cent.

During these trials a great number of indicator diagrams were taken from both engines. Space will not permit us to reproduce these diagrams, many of which are given in the memoir of M. du Bousquet, but his general statement of the results is that they approached very nearly to the theoretic diagrams, which he had constructed while studying the question before undertaking the actual experiments, and that the calculations which he had then made were confirmed by experience in a very remarkable way. His general conclusions on this engine may be summed up as follows:

The compound engine draws, on lines of high grade, loads 12 per cent. greater than the ordinary engine of the same class, while securing a considerable economy in fuel, and not increasing the cost of lubrication.

The point which remains to be determined is whether the expense of repairs and maintenance will be increased. This question must be studied and tested by the continued service of the engine, because a short trial is not sufficient, and because also it would not be fair to take account of the minor points in which alteration may be found necessary or of mistakes resulting from the uncertainties always attending a first trial.

It may be said, however, with certainty, that there will be no trouble with the valves, and that they will not require more attention than the valves of the ordinary simple cylinder.

THE EIFFEL TOWER IN PARIS.

THE most prominent object at the Paris Exposition this year will be the great tower designed and built by M. Eiffel, which will be 300 meters (984 ft.) in height, and will therefore be the loftiest artificial structure in the world. This tower is now well advanced toward completion, and some account of it may be interesting.

As the total weight of this tower will be about 9,000 tons, substantial foundations were necessary. It is placed near the banks of the Seine, at a point where the subsoil is a bed of plastic clay, sloping rapidly toward the river. The general form of the tower, which is probably well known to most of our readers, and which may be seen from the illustration given in the January number of the JOURNAL, page 12, is that of four legs or pillars springing from the corners of a square of 100 meters, and uniting in one at the height of about 100 meters above the ground.

The four metallic towers rest each upon a huge pile or pier of masonry, placed at one corner of the square. The first step was to ascertain the exact nature of the subsoil by frequent and careful borings. From these it was ascertained that the two piers on the side farthest from the river could rest upon the solid subsoil at a depth of about 7 meters below the surface. The foundations to these piers were made without difficulty in an open excavation, and consist of a bed of beton 2 meters in thickness, upon which the masonry is built up to the surface.

For the two piers near the river it was found necessary to make further foundations, and for each of them there were sunk four caissons, each 6 × 15 meters, of wrought iron; these were sunk 12 meters below the surface, and 5 meters below the water-level, resting upon the hardpan, which is here a very coarse gravel and very compact.

The piers have the form of a pyramid, the two inner faces being straight, while the two outer faces are inclined in the same directions as the pillars in the tower. In one of the piers there has been made a room, in which will be placed the engine running the elevators and other machinery.

Each pier has a top of heavy cut-stone masonry, upon which is placed a large shoe, or socket, of cast iron, weighing about 6,000 kilogrammes, which is fastened to the masonry by two anchor-bolts 7.80 meters in length and 0.10 meter in diameter. The service of these bolts, however, is temporary only, as the weight of the tower when finished will be quite sufficient to hold them in place without any anchorage.

These shoes receive directly the four uprights or girders which are the main members of each branch of the tower. These girders are built up of plates and angle-irons riveted together, the different sections being entirely fitted in the workshop so that they can be put together without delay. The cross-bracing and connections between the main girders are put on for each section as it is put in place.

The erection of each of the legs was made by the aid of wooden false-work until it reached the height of 26 meters. At this point a change was necessary, for the reason that the inclination of the members would have carried their center of gravity outside the base of the tower, and the further progress of the work would have resulted in its fall.

At this point, therefore, heavy scaffoldings of wood are put up, having the form of triangular pyramids, with the apex bearing against the pillars and supporting them. These were so arranged that the erection of the towers could be continued safely.

At the height of 48 meters above the foundation, the four pillars are joined by an immense horizontal girder, 7 meters in depth and 42 meters in length on each side of the square. A difficult problem was here presented, that of putting these girders in place, without support except at the ends; it was solved by erecting in the center of each side of the square a wooden tower upon which the girder was erected, so that nothing further remained than to join its extremities to the branches of the tower.

In order to provide against any slight irregularity which might be found in the heights of the branches of the tower, there was provided upon each foundation a hydraulic press having a lifting force of 800 tons, and by this the level of the pillars could be regulated to the smallest fraction; thus the connection between the legs and the girders of the first section was made without the slightest difficulty, although, as has been said, all the sections were fitted and finished to their proper length in the workshop, only their erection being done on the ground.

The girders of the first stage being in position, a new base was presented, from which the erection of the tower could proceed, and the work here was simply a repetition of that below, the only difference being that it started from staging placed upon the girders, instead of the surface of the ground.

The hoisting and placing of the members of the different sections was performed by cranes, so arranged that they could gradually be raised as the work proceeded. In each of the four pillars there were arranged two girders intended to form a road for what might, for want of a better term, be called the hoisting cabin. In these girders there had been placed, at regular intervals, holes drilled in the flanges; the pivot cranes were placed in a small cabin, or building, in the form of a pyramid, with the base upward, serving as a platform for the workmen, while the apex held the step carrying the pivot of the crane. One face of the pyramid was arranged to correspond with the girders of the tower, and the two beams forming its upright side had holes bored in their flanges also, so that they could be bolted at any point to the girders of the frame. The platform thus fixed in place, the crane hoisted and distributed the material. When its work on that section was finished it raised itself over the section, by means of a crab of peculiar construction, and was again bolted fast in the new position. This process was repeated as often as necessary.

Four of these cranes, one for each branch of the tower, were provided; they were capable of lifting 3 tons each, and were found in practice very efficient. After reaching the top of the first stage they were continued in service, but on the girders of this stage there was placed a special hoisting machine, with an engine of 12 H.P., which raised the material from the ground to this stage, where a circular track distributed it to the four cranes. The same method, with such modifications as may be found necessary, will be continued to the summit of the tower.

The objections originally made to the tower were that the weight of such a structure would be too great for the foundations, and that it would be liable to destruction from the oscillations caused by the wind. It is claimed, however, that, owing to the adoption of iron and steel as material, the weight carried by the foundations is really less than that of some of the larger buildings in Paris, while the system of wind-bracing is so complete, and the tower has been so carefully proportioned to resist wind pressure, that the oscillation will be hardly perceptible.

To a minor objection raised, the danger to persons on the tower during thunder-storms, it is replied that the tower has been connected with the water-bearing strata of the subsoil, so that the entire structure is, in effect, a huge lightning conductor, and that the effect of the most severe shock would be so distributed as to be imperceptible at any point.

The arrangements made for sightseers during the Exposition are very complete. There will be staircases provided for visitors, but most of them will probably prefer to use the elevators. From the ground to the first stage (48 meters) there will be four elevators, one in each branch of the tower, capable of carrying 100 persons at a time. From the first to the second stage two swift elevators will be provided, each carrying 50 persons. From the second to the third or final stage there will be a single elevator capable of carrying 750 people an hour. In this last the passage will not be made from the second to the third stage in the same car, but the trip will be in two parts; that is, leaving the second stage visitors will be carried by the first elevator to a height of 196 meters, where they will pass over an intermediate platform and take a second elevator, which will carry them to the third or top stage, 277 meters above the ground. The ascent of the last stage is so divided because one of the cars serves as a counterbalance to the other, so that while one descends the other rises, and *vice versa*.

The arrangements for entertaining visitors to the tower are not yet entirely fixed, but on the first stage, which has an area of 4,200 sq. meters, there will be four restaurants, one at each angle; four large halls, each 37 × 15 meters; four balconies on the inside of the huge quadrilateral, and finally an exterior balcony, 3 meters in width, by passing around which a complete panoramic view of Paris can be obtained.

The second stage has an area of only 1,400 sq. meters, but will contain a restaurant and a dancing hall, while an outer balcony, like that of the first stage, will give visitors a view of Paris from a height of 151 meters.

The third stage, the highest part accessible to the public, has its floor 277 meters above the ground, and will have a surface of 370 sq. meters. This hall will be entirely covered in with glass. Above this M. Eiffel has reserved a space 10 meters square in which he will make a special room for such experiments as may be suggested by scientists. Above this room will be placed a heavy girder, which will carry the pulleys of the elevator; upon this girder will be placed a small tower, in which there will be a staircase giving access to a lantern 5 meters in height, which will be lighted by an electric light. A ball is placed on top of the lantern, and above it rises a lightning-rod, the top of the ball being exactly 300 meters above the ground.

It is claimed by the designer of this huge structure that, above and beyond its services as an attraction to visitors to the Exposition, it will have a permanent scientific value.

Meteorologists will find in it a valuable auxiliary in their experiments on the speed and the pressure of the wind at different heights above the ground; on the law of the changes of temperature with height; on the hygrometric state and the analysis of the air at different heights, and on atmospheric electricity.

Astronomers will be able to use it for the examination of the telluric rays of the sun, for photography, and for the spectroscopic examination of rays of light from the stars, which can be made under conditions not heretofore attainable, because the summit of the tower will be raised completely above the vapors arising from the earth.

In physics it can be used to verify the laws of the deviation of a falling body, and the experiments of the Foucault pendulum; also for the installation of manometers, for the study of the law governing the compression of gases, since a direct graduation can be made up to 400 atmospheres.

Physiologists will find in the tower an excellent place for the study of the air with respect to freedom from bacteria and other impurities, and also for the study of the influence of the air upon the circulation of the blood at such heights; studies on the flight of birds, etc.

Finally, from a military point of view, the tower will furnish an observatory, the value of which can hardly be appreciated, since no similar one has ever yet been provided.

Thus, it is claimed, the tower will be not a mere object of curiosity, but a structure capable of rendering signal services to the national defence and to science. Whether these claims will be justified or not, the tower is an interesting structure and commands attention from its great size alone, if for no other reason.

UNITED STATES NAVAL PROGRESS.

THE following notes show the progress of the work made in the reconstruction of the Navy, giving such occurrences of the past month as appear to be of interest.

NEW SHIPS.

The Senate Naval Committee has added to the House bill appropriations for a new steel cruiser of 2,000 tons displacement, to cost $700,000; and for two steel gunboats of not more than 1,200 tons dsplacement, to cost $700,000. The Committee has also approved the appropriation of $1,500,000 for the construction of the coast defense vessel designed by Mr. Thomas. Besides these, the bill includes appropriations of $450,000 for a new dynamite gun-boat, and $140,000 for four steam tugs. The bill, it is thought, will pass with all these appropriations.

The new gun-boat *Yorktown*, having successfully passed the preliminary trial, is now undergoing a sea trial, in charge of the Board of Naval Officers.

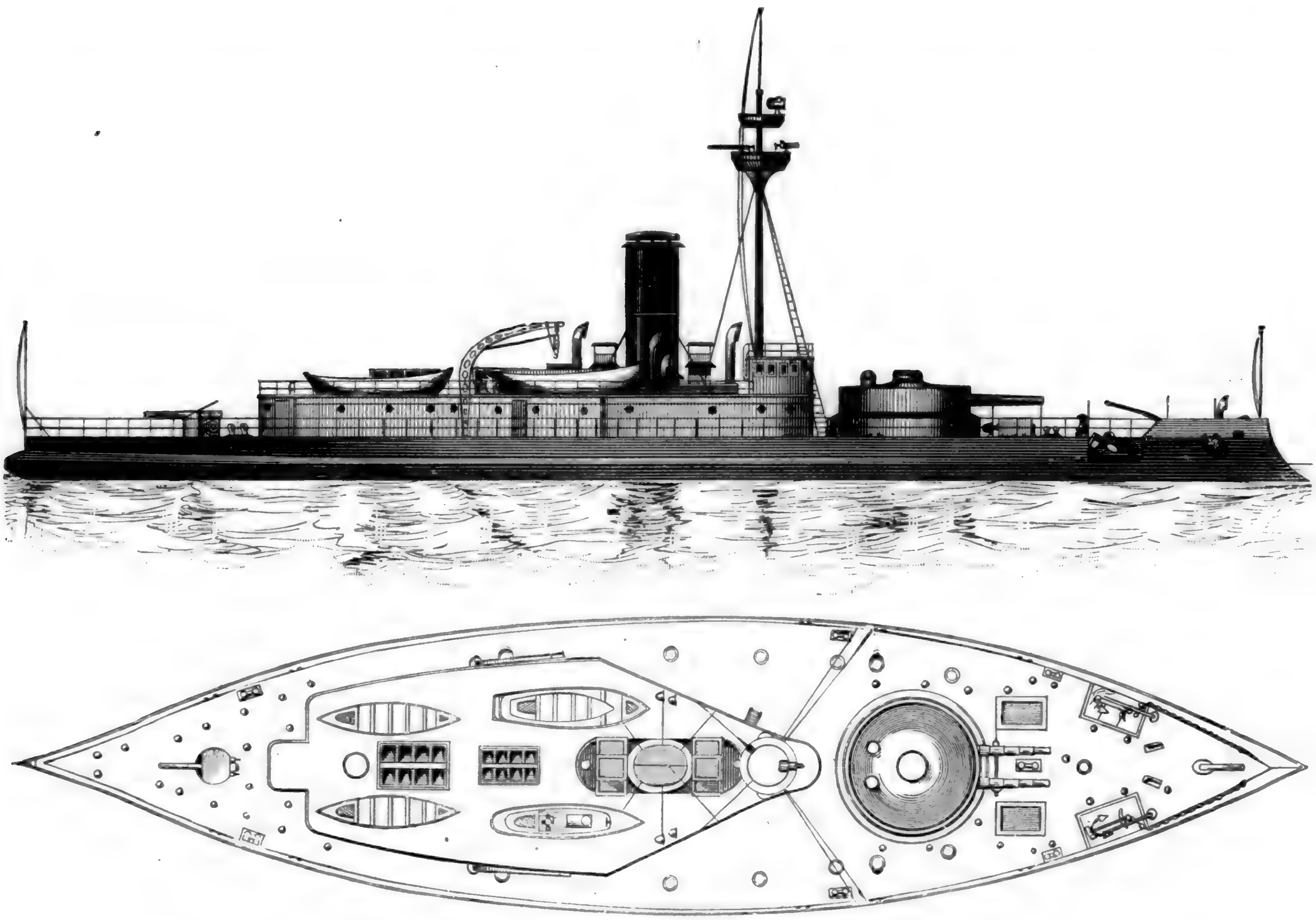
The cruiser *Charleston*, which was built at San Francisco, will also be taken to sea for her final trial about the latter part of this month, making a trip down the coast from San Francisco, when her performance will be carefully noted.

The cruiser *Baltimore*, under construction at Cramps' yard in Philadelphia, has received her engines, and will be ready for the steam trial in about two months.

The *Philadelphia*, at the same yard, has her hull now nearly completed, and will be ready for launching in April. The hull of the *Newark* is also well advanced, and she will be ready to launch soon afterward.

Notice is given that proposals for the machinery of the new armored battle-ship *Texas* will be received at the Navy Department until noon on April 3. The proposals must include all the machinery—engines, boilers, screw propellers, shafting, pumps and all appurtenances, including appliances for working under forced draft. The machinery must be delivered complete and ready for erection on board the vessel within two years and six months from the date of the contract. The contract will contain provisions relating to premiums on penalties in connection with the development of horse power according as the same shall be above or below the required maximum. The proposals will be divided into three classes as follows: 1. For machinery in accordance with the plans and specifications provided by the Department. 2. For machinery in accordance with such plans, with modifications as proposed by the bidder. 3. For machinery in accordance with plans and specifications submitted by the bidder, such plans to conform to the weight and space provided for in the general plans of the vessel. Bids under classes 2 and 3 must be accompanied by plans and drawings sufficient to show the designs satisfactorily. Plans, specifications, and blank forms can be obtained on application to the Chief of the Bureau of Steam Engineering, Navy Department.

A conference was held recently at the Navy Department, at which a number of steel manufacturers were present, and the regulations for the inspection of steel for the new naval vessels were discussed, but no definite action was taken and no change in the rules were ordered.



THE SUBMERGING MONITOR CRUISER.

NEW GUNS.

The 6-in. gun, cast by the Standard Steel Casting Company at Thurlow, Pa., had its preliminary test at the proving ground at Annapolis, February 7. Twelve rounds

were fired, two with charges of 36 lbs. of powder and a 100-lbs. shell, and 10 with charges of $48\frac{1}{2}$ lbs. of powder and 100-lbs. shells. The gun stood this test very successfully, and was reported as entirely sound after the test. It has still to undergo what is known as the endurance test.

The official trial of the large dynamite gun, which recently took place, was very successful. Nine shots in all were fired with the large 450-lbs. shell, and of these five fell within a rectangle 50×100 ft., as specified in the contract with the Department. The ranges varied from 2,009 to 2,177 yards.

The report of the Board has not been published, but must have been favorable, for the Secretary of War has since given out a contract to the Pneumatic Dynamite Gun Company to furnish seven dynamite guns, with the steam-power and air compressors necessary for working them, the contract price being $395,500, the guns to be delivered within eight months. Of these seven guns two 15-in. and one 8-in. are to be put at Sandy Hook, New York Harbor; two 15-in. guns at Fort Schuyler on Long Island Sound, and the remaining two 15-in. guns at Fort Warren in Boston Harbor.

THE THOMAS SUBMERGING MONITOR.

We give herewith an illustration, for which we are indebted to the *Army and Navy Register*, of this vessel, whose peculiarities have excited much attention, and we add also some particulars to the description given last month.

The principal dimensions are as follows: Length on load line, 235 ft.; extreme breadth, 55 ft.; cruising draft, $14\frac{1}{2}$ ft.; displacement at cruising draft, 3,030 tons; coal supply carried, 550 tons. The engines are to work up to 7,500 H.P. with forced draft, and the extreme speed is to be 17 knots. The draft can be increased to $17\frac{1}{2}$ ft. for fighting purposes, by means of tanks which can be very quickly filled. The vessel is to be strengthened by a system of longitudinal and transverse girders, and is to be provided with a formidable bow for ramming. With the engines working without forced draft, and with an average speed of 10 knots, the vessel will have a cruising range of 8,500 knots.

The character of the armament is as follows: Two 10-in. breech-loading rifles for long range, with capacity for throwing shell charged with high explosive compounds. These guns are mounted in a turret armored with 10-in. solid steel plates, the axis of the guns when level being 11 ft. above the fighting load line, with a range of fire from direct ahead to 65° abaft the beam on either side, and by removing the deck-house increasing the range to a practically all-around fire. For close quarters she has a 15-in. Zalinski dynamite gun capable of throwing 800 lbs. of high explosive compound, and two under water bow torpedo tubes, also a 6-in. rapid-firing breech-loading rifle located aft. The secondary battery consists of three 3-pounder rapid-firing and one 37-mm. revolving gun.

THE LATEST ENGLISH CRUISERS.

(From the London *Engineer*.)

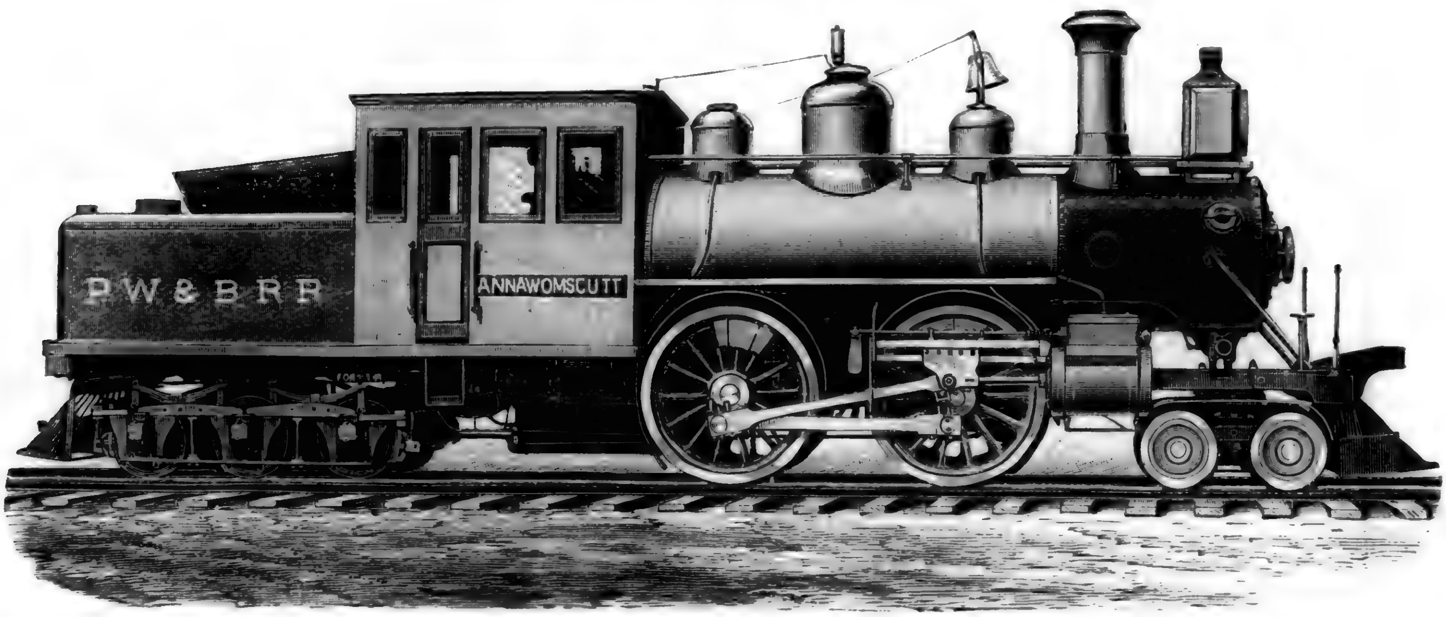
THE *Australia* and the *Galatea*, the latest additions to the Navy, built and engined by R. Napier & Sons, Glasgow, belong to the class of swift and powerfully armed belted cruisers, specially designed for the protection of commerce. Their principal dimensions are: Length between perpendiculars, 300 ft.; breadth, extreme, 56 ft.; depth, moulded, 37 ft.; with a displacement of 5,000 tons at 19 ft. draught when in the normal fighting condition, but this may be increased to 6,000 tons when an extra supply of coal is shipped. The belt which protects the water-line for two-thirds of the length consists of steel-faced compound armor 10 in. thick, strongly supported by steel and teakwood backing, and terminates at each end in an athwartship iron bulkhead 16 in. thick to stop end-on shot. Level with the top of the armor belt is a protective steel deck, 2 in. thick on the flat, and 3 in. on the angle, where it slopes down below the water-line, and this deck also extends to the stem and stern respectively. All the machinery of vital importance, including the steering gear, air compressors, electric dynamos, etc., is placed under the protective deck, while above it, for the length of the engine and boiler-rooms, the sides are defended by coal, and an armor-plated conning tower on the upper deck is fitted with steering gear, telegraphs, etc., for working the ship when in action. While every precaution is thus taken to keep out shot and shell, the buoyancy in case of penetration is insured by the minute subdivision of the underwater portion of the hull which contains upward of 130 separate water-tight cells and compartments. The armament consists of two long range 22-ton breech-loading guns and central pivot mountings on the upper deck, forward and aft respectively; ten 6-in. guns similarly mounted on the broadside; eight 6-pounder, and eight 3-pounder, quick-firing guns, also six torpedo tubes. The engines, which were designed by Mr. A. C. Kirk, the senior partner of Messrs. Napier's firm, were originally specified by the Admiralty to be of the ordinary compound type for 7,500 H.P.; but from their previous experience Messrs. Napier were able to show that by substituting triple expansion engines they could guarantee an increase of 1,000 H.P., and almost a knot more speed, thereby enormously increasing the value of the ship as a fighting machine, without adding to the total weight of machinery and coal, or occupying more space. This suggestion was eventually adopted by the Admiralty, and also carried out in the other ships of the class.

The two sets of engines are of the three-crank horizontal type, working twin screws, and are placed one before the other in separate water-tight compartments, the cylinders being 36 in., 51 in., and 77 in. in diameter and 44-in. stroke. Steam is supplied by four double-ended boilers, of the return-tube type, which are placed forward of the engines in two independent stokeholds divided by water-tight bulkheads. The results of the official trials were highly satisfactory, and fully justified the contractors' proposal to introduce the triple-expansion engines.

In the case of the *Galatea*, the collective horse-power on the four hours' forced draught trial was 9,204, being more than 700 H.P. in excess of the contract; the highest power developed during any single half-hour was 9,665 H.P., and the mean of the last three hours gave 9,415, equal to 1,915 indicated H.P. above what was originally proposed by the Admiralty. This splendid result was attained on a consumption of 1.97 lbs. of coal per indicated H.P. per hour with an air pressure in the stokeholds of only $1\frac{1}{4}$ in., and that while working as pure triple-expansion engines, without passing boiler steam into the receivers, and the steam was supplied in such abundance that with the engines working at their maximum there was a constant blow-off.

Hicks' "Centrifugal" Gun.—A very novel machine, for the discharge of dynamite projectiles, shells, and solid shot from the periphery of a rapidly-revolving wheel has been invented by Walter E. Hicks, of Brooklyn. Mr. Hicks expects an initial velocity of 2,000 ft. a second from his 10-ft. wheel, when flying at the rate of 4,000 revolutions a minute. The motive power is a steam-engine. The wheel consists of two steel disks, thin at the circumference, but quite thick at the center, standing several inches apart and firmly joined by bolts. Outside each disk is a double quadrant for the use of the gunner in training the gun at a desired elevation. Combined with each quadrant is a mechanical contrivance that, by the pulling of a lanyard, opens a clutch and releases a projectile at just the point at which the gun may be trained. Two shots at opposite sides of the wheel are thus fired, an infinitesimal fraction of a second apart. A wheel 10 ft. in diameter is required for a 6-in. shot, and for every additional inch of diameter in the shot there must be 20 in. more of diameter in the wheel according to Mr. Hicks's calculations. The entire machine, including the steam-engine, stands upon a single plate that may be placed upon a turn-table and adjusted like any marine gun-carriage. The projectile especially designed to be used in this machine is a long cigar-shaped shell, with heavy solid ends, the intervening space being occupied by camphorated nitro-gelatine surrounded by gun-cotton, as in the Zalinski projectile.

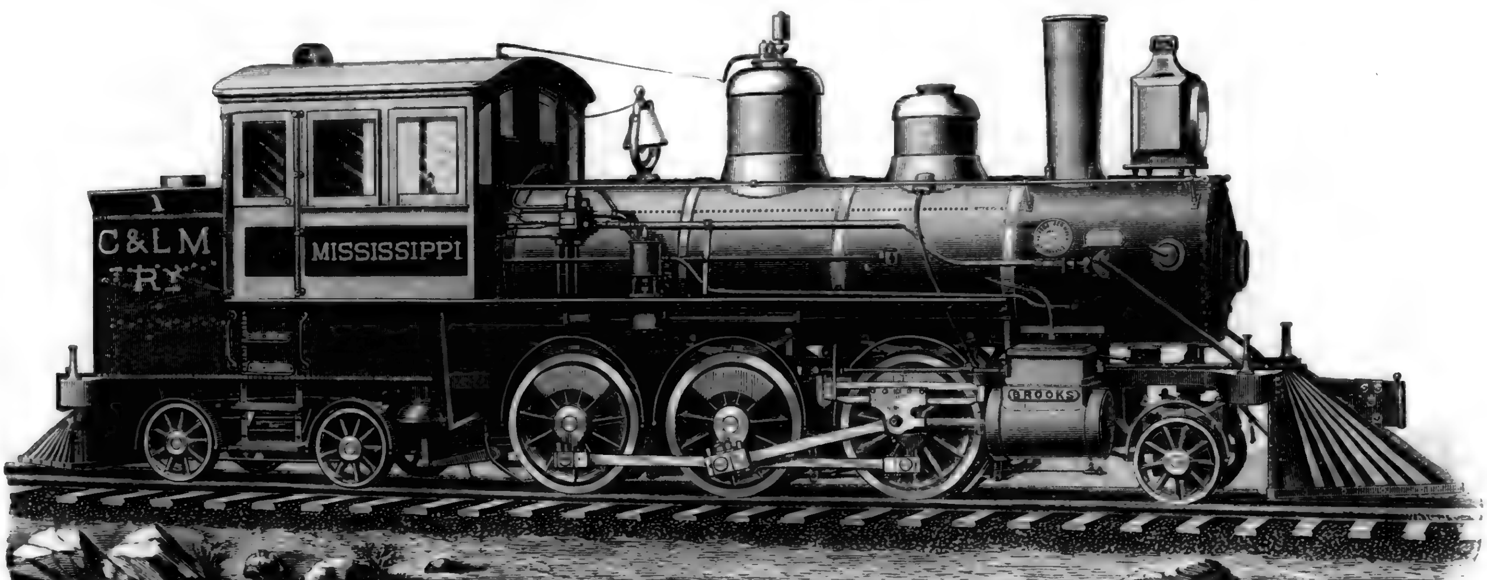
CATECHISM OF THE LOCOMOTIVE.



LOCOMOTIVE FOR LOCAL PASSENGER SERVICE.

BY THE TAUNTON LOCOMOTIVE MANUFACTURING COMPANY, TAUNTON, MASS.

Total weight in working order	118,700 lbs.
Total weight on driving-wheels	56,300 "
Diameter of driving-wheels	5 ft. 3 in.
Diameter of truck-wheels	2 " 2 "
Diameter of main driving-axle journal.	7½ "
Distance from center of front to center of back driving-wheel	6 ft. 8 "
Total wheel-base of engine	16 " 4 "
Total wheel-base of engine and tender	34 " 5 "
Diameter of cylinders	17 "
Stroke of cylinders	20 "
Outside diameter of smallest boiler ring.	54 "
Length of fire-box, inside	5 ft. 0 in.
Width of fire-box, inside	2 " 10½ "
Depth of fire-box, crown-sheet to top of grate	5 " 4 "
Number of tubes	170
Outside diameter of tubes	2 in.
Length of tubes	10 ft. 10¼ "
Grate surface	14 sq. ft.
Heating surface, fire-box	96¼ " "
Heating surface, tubes	1,097 " "
Heating surface, total	1,193¼ " "
Exhaust nozzles	Single.
Size of steam-ports	17×1 in.
Size of exhaust-ports	17×2½ "
Throw of eccentrics	4½ "
Greatest travel of valve	5 "
Outside lap of valve	0¾ "
Smallest inside diameter of chimney	1 ft. 4 "
Height, top of rail to top of chimney	13 " 6 "
Height, top of rail to center of boiler	6 " 8 "
Water capacity of tank	2,200 gals.

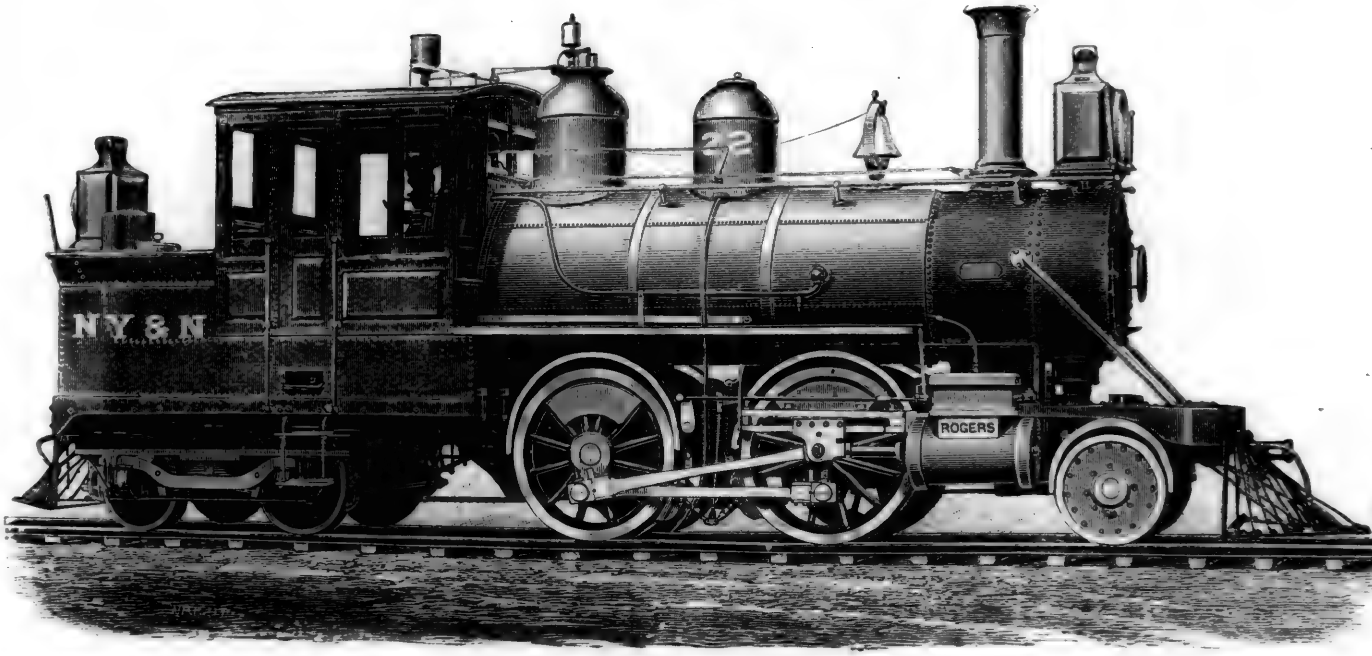


SIX-COUPLED RAPID TRANSIT LOCOMOTIVE.

BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N. Y.

Total weight in working order	112,000 lbs.
Total weight on driving-wheels	70,000 "
Diameter of driving-wheels	4 ft. 0 in.
Diameter of truck-wheels	2 " 4 "
Diameter of main driving-axle journal.	7 "
Distance from center of front to center of back driving-wheel	10 ft. 0 "
Total wheel-base of engine	30 " 0 "
Diameter of cylinders	16 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler ring	54 "
Length of fire-box, inside	6 ft. 6 in.
Width of fire-box, inside	2 " 10 "
Depth of fire-box, crown-sheet to hand ring	5 " 1½ "
Number of tubes	186
Outside diameter of tubes	2 in.
Length of tubes	9 ft. 0 "
Grate surface	18¾ sq. ft.
Heating surface, fire-box	97 " "
Heating surface, tubes	870 " "
Heating surface, total	967 " "
Exhaust nozzles	Single or Double.
Size of steam-ports	15×1¼ in.
Size of exhaust-ports	15×2½ "
Throw of eccentrics	5 "
Greatest travel of valve	5¼ "
Outside lap of valve	0¾ "
Smallest inside diameter of chimney	1 ft. 1 "
Height, top of rail to top of chimney	13 " 2 "
Height, top of rail to center of boiler	6 " 4½ "
Water capacity of tank	2,000 gals.

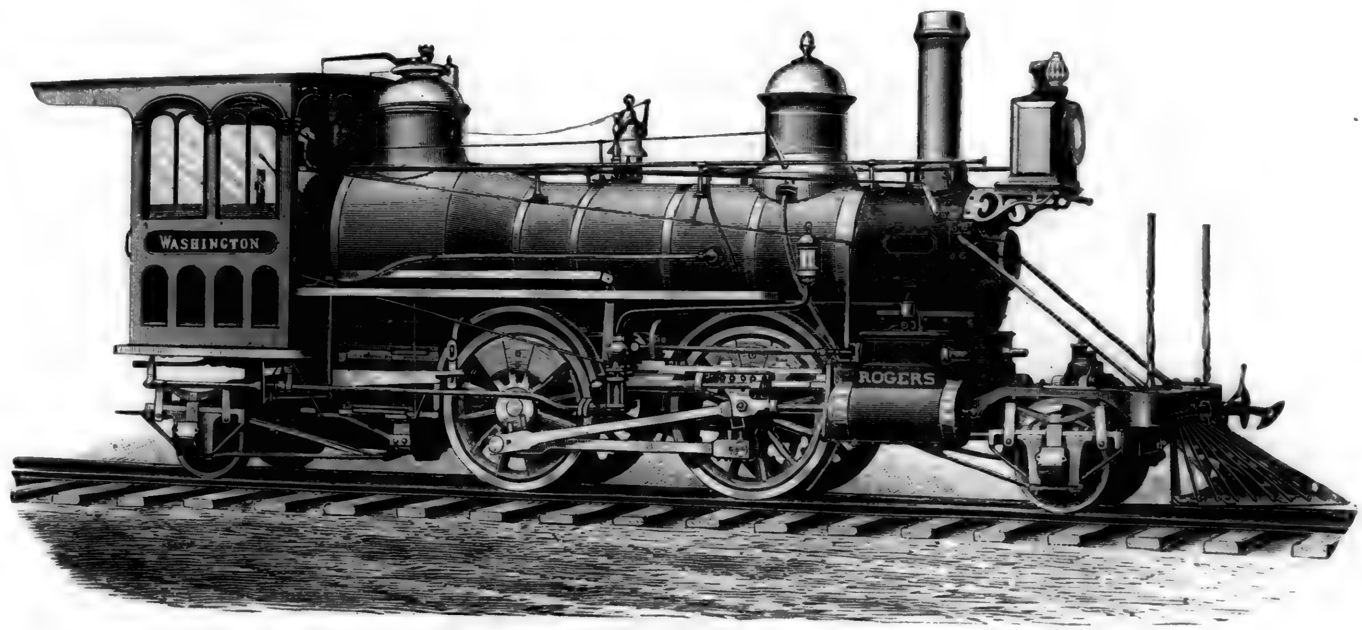
CATECHISM OF THE LOCOMOTIVE.



LOCOMOTIVE FOR SUBURBAN PASSENGER SERVICE.

BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	98,500 lbs.	Length of fire-box, inside	5 ft. 11½ in.	Exhaust nozzles	Double.
Total weight on driving-wheels	50,000 "	Width of fire-box, inside	3 " 5 "	Size of steam-ports	14×1⅛ in.
Diameter of driving-wheels	4 ft. 6 in.	Depth of fire-box, crown-sheet to top of grate	3 " 0 " / 3 " 5¾ "	Size of exhaust-ports	14×2½ "
Diameter of truck-wheels	2 " 9 "	Number of tubes	186	Throw of eccentric	5 "
Diameter of main driving axle-journal.	6⅛ "	Outside diameter of tubes	1¾ in.	Greatest travel of valve	5 "
Distance from center of front to center of back driving-wheels	6 ft. 3 "	Length of tubes	7 ft. 10¾ "	Outside lap of valve	0¾ "
Total wheel-base of engine	27 " 0 "	Grate surface	20½ sq. ft.	Smallest inside diameter of chimney	11⅜ "
Diameter of cylinders	14 "	Heating surface, fire-box	77¾ " "	Height, top of rail to top of chimney	14 ft. 0 "
Stroke of cylinders	22 "	Heating surface, tubes	667¾ " "	Height, top of rail to center of boiler	6 " 10⅛ "
Outside diameter of smallest boiler ring	52 "	Heating surface, total	745½ " "	Water capacity of tank	1,000 gals.



HUDSON DOUBLE-ENDER LOCOMOTIVE.

BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

Total weight in working order	51,100 lbs.	Length of fire-box, inside	4 ft. 3 in.	Exhaust nozzles	Double.
Total weight on driving-wheels	30,500 "	Width of fire-box, inside	2 " 1 "	Size of steam-ports	10⅛×1 3/16 in.
Diameter of driving-wheels	4 ft. 0¾ in.	Depth of fire-box, crown-sheet to top of grate	4 " 0¾ "	Size of exhaust-ports	10⅛×2½ "
Diameter of truck-wheels	2 " 2 "	Number of tubes	100	Throw of eccentric	4½ "
Diameter of main driving-axle journal.	5½ "	Outside diameter of tubes	2 in.	Greatest travel of valve	4⅜ "
Distance from center of front to center of back driving-wheels	6 ft. 0 "	Length of tubes	10 ft. 2½ "	Outside lap of valve	0 13/16 "
Total wheel-base of engine	22 " 1 "	Grate surface	8⅞ sq. ft.	Smallest inside diameter of chimney	10⅜ "
Total wheel-base of engine and tender	39 " 2½ "	Heating surface, fire-box	61 " "	Height, top of rail to top of chimney	11 ft. 4½ "
Diameter of cylinders	12 "	Heating surface, tubes	534⅜ " "	Height, top of rail to center of boiler	5 " 7 "
Stroke of cylinders	20 "	Heating surface, total	595⅜ " "	Water capacity of tank	1,250 gals.
Outside diameter of smallest boiler ring	39⅜ "				

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 90.)

CHAPTER XXIV. *(Continued.)*

PROPORTIONS OF LOCOMOTIVES.

QUESTION 623. *On what does the steam-generating capacity of a boiler depend?*

Answer. First, upon the size of its grate and fire-box, because more fuel can be burned in a large fireplace than in a small one; second, on the amount of heating surface to which the products of combustion are exposed; and, third, on the draft produced by the blast or exhaust steam. Of course the amount of steam generated is also dependent upon a great variety of other circumstances, such as the nature of the combustion, the firing, the arrangement of the fire-box, grates, etc., and the condition of the heating surfaces; but these have nothing to do with the proportions or size of the boiler.

QUESTION 624. *What are the proportions of boilers used in locomotives like that which has been illustrated in these articles and represented in Plates III–V?*

Answer. The area of the grate is about 18 square feet, and the total heating surface about 1,600 square feet.

QUESTION 625. *At what speed are such engines usually run?*

Answer. The speed varies so much under different circumstances, that it is impossible to give even approximately the average speed of such engines.

QUESTION 626. *In what respects is the operation of locomotive boilers different from that of nearly all other steam boilers?*

Answer. The amount of steam generated in proportion to the amount of heating surface is much greater in locomotive boilers than in any other kind. To produce combustion which will be sufficiently active to generate the requisite quantity of steam, the fire must be stimulated by the blast created by the exhaust steam to a degree unknown in other kinds of boilers. So rapid is the movement of the products of combustion that a smaller proportion of the heat is imparted to the water contained in the boiler, and consequently a less amount of water is evaporated in proportion to any given amount of fuel than in boilers in which combustion is less violent. The combustion is often less complete, because the strong draft does not allow time for a perfect combination of the gases which produce combustion.

The supply of steam which a locomotive boiler must furnish is also much more irregular than the demands made upon any other kind of boiler. At one time the fire must be urged to the greatest possible intensity, in order to furnish steam enough to pull a train up a steep grade. When the top is reached the demand ceases, and the boiler can be cooled. The load which a locomotive can pull over a given line of road is usually limited by the utmost capacity of the boiler to supply steam at these critical periods.

QUESTION 627. *What relation is there between this irregular action and the size of the boiler?*

Answer. The smaller the boiler, or rather the larger the amount of steam which must be generated in a given time in proportion to the heating surface, the more must the fire be urged; and therefore the smaller the boiler in proportion to the work it must do, the less will be its economy. In order to produce a rapid combustion in a small boiler, it is necessary to contract the exhaust nozzles in order to create a draft strong enough. In doing this the back pressure on the pistons is very much increased, and when the blast becomes very violent a great deal of solid coal is carried through the tubes and escapes at the smoke-stack unconsumed. At the same time large quantities of unconsumed gases escape, because there is not time for combustion to take place in the fire-box. The fact that with a violent draft the flame and smoke are in contact with the heating surface for a sensibly shorter period of time also has its influence; as less heat will be imparted to the water if the products of combustion are only $\frac{1}{100}$ of a second instead of $\frac{2}{100}$ in passing through the tubes.

There is another consideration which should be taken into account in this connection, which is, that if a boiler is so small that it is worked nearly up to its maximum capacity at all times, it will be impossible to accumulate any reserve power in it in the form of water heated to a high temperature to be used as occasion may require. With a boiler having a great amount of heating surface and capacity for carrying a large quantity of water, the latter can be heated at times when the engine is not working hard, and the heat thus stored up in the water can then be used when it is most needed. Thus we will suppose that to pull a train of cars on a level 250 lbs. of steam are consumed per mile. On a grade of 30 feet per mile the resistance will be three times what it is on a level, and therefore three times the quantity of steam will be consumed, so that the boiler must then evaporate 750 lbs. of water per mile. Now, to convert 250 lbs. of water heated up to a temperature due to 130 lbs. of effective pressure, or 355.6 degrees, into steam of that pressure will require 216,575 units of heat. If at the same time that this steam is being consumed, we pump into the boiler 250 lbs. of water of a temperature of 60 degrees, 73,900 more units of heat will be needed to raise the water to the temperature due to 130 lbs. effective pressure, so that on the level part of the road it would be necessary to transmit to the water in the boiler 216,575 + 73,900 = 290,475 units of heat in a mile. If there is no room in the boiler for storing a surplus quantity of hot water, it will be necessary on a grade as fast as the steam is consumed to feed an equivalent amount of cold water to take the place of that which was converted into steam, so that on a 30-feet grade it would be necessary to convert at the rate of 750 lbs. of hot water into steam in a mile, which would require 649,725 units of heats, and at the same time heat an equal amount of cold water to a temperature due to the pressure of the steam, which would require 221,700 more units. So that it will be necessary to transmit at the rate of 871,425 units of heat to the water per mile. Now, if the boiler was so large that more water could be pumped into it and heated than was used on the level portion of the road, and could be stored up in the boiler for future use, the pumps might be either partly or entirely shut off when the engine was working the hardest on the grade. In this way, instead of being obliged to convert hot water into steam, and at the same time heat an equal amount of cold feed-water, there would be a surplus of hot water stored up already heated. It would therefore only be necessary to convert this hot water into steam, which will require a transmission of heat to the water at the rate of 649,725 units of heat instead of 871,425. It must be remembered that on nearly all roads there are certain difficult places which practically limit the capacity of the locomotives on that line. If therefore the capacity of the engines can be increased at those points, their capacity over the whole line is increased. It will be seen by the above illustration that by having a large boiler it is necessary for it to do very much less work at the critical period, when, as every locomotive runner knows, it is often of the utmost importance to make use of every possible available means in order to pull the trains. It is true that on a very long grade the supply of surplus hot water would soon be exhausted, but even in such cases there is usually one place, owing to a curve or other cause, which is more difficult to surmount than any other, in which case it will be necessary to use more steam for a short time than the locomotive can generate if the boiler is fed continuously. For such cases a surplus of water can be used. But even if the resistance is equal over the whole length of the incline, still the large boiler will have the advantage, because it can at all times generate more steam than a smaller one. It may therefore, we think, safely be assumed that locomotive boilers should always be made as large as the weight of the locomotive will permit.

QUESTION 628. *What effect does the size of the driving-wheels have upon the combustion and evaporation of locomotive boilers?*

Answer. As small wheels make more revolutions in running a given distance than large ones, there will be more strokes of the piston with the former than with the latter, if the locomotive in both cases runs at the same speed. As smaller cylinders are usually employed with small wheels, the blast up the chimney is then composed of a larger number of discharges of steam, but each one of less quantity, than when larger wheels and cylinders are used. In the one case the "puffs" of steam are many and small, and in the latter few and large. If the cylinders are proportioned by the rule which has been given for that purpose, the amount of steam discharged in running any given distance will be the same with engines of the same weight having large and those with small wheels, the only difference being that it will be subdivided into a greater number of discharges in the one case than in the other. Now, it is found that the draft of engines is much more effective on the fire when the blast is thus subdivided, that is when small wheels and cylinders are used, than it is with large ones, and therefore more steam is generated with the former than with the latter.

QUESTION 629. *What relation is there between the size of the wheels and that of the boiler?*

Answer. As has been explained, the size of the boiler is limited by the weight of the locomotive. The boiler and its attachments of an American type of locomotive, when the former is filled with water, weigh about half as much as the locomotive; therefore unless we increase the weight of the latter or decrease

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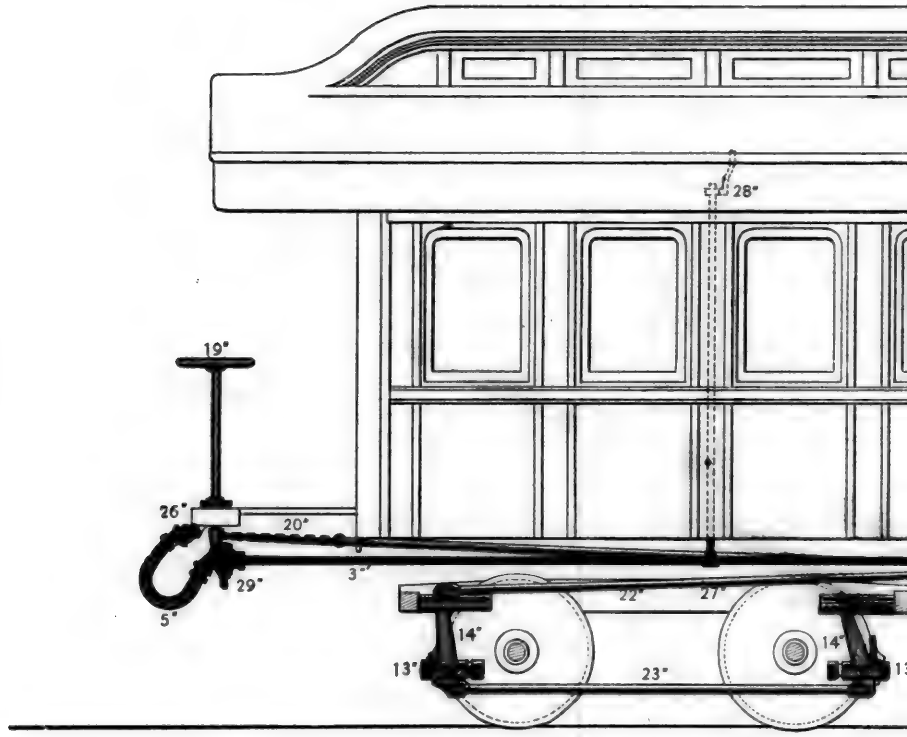

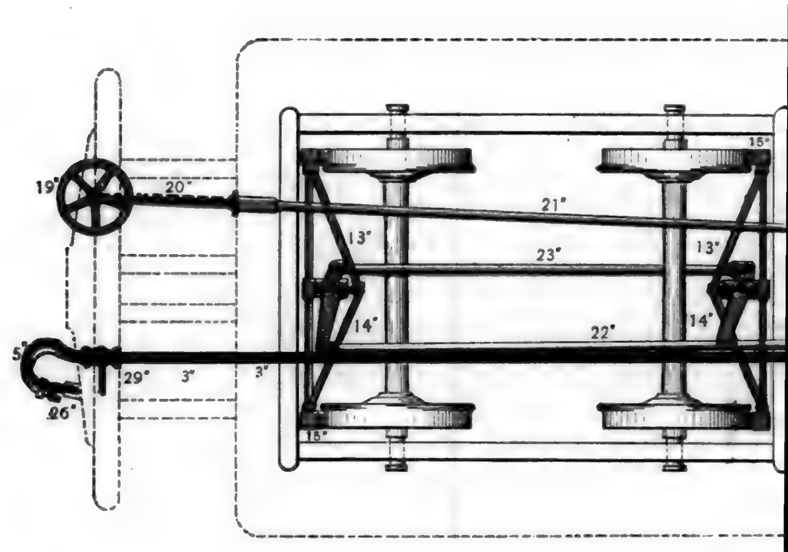

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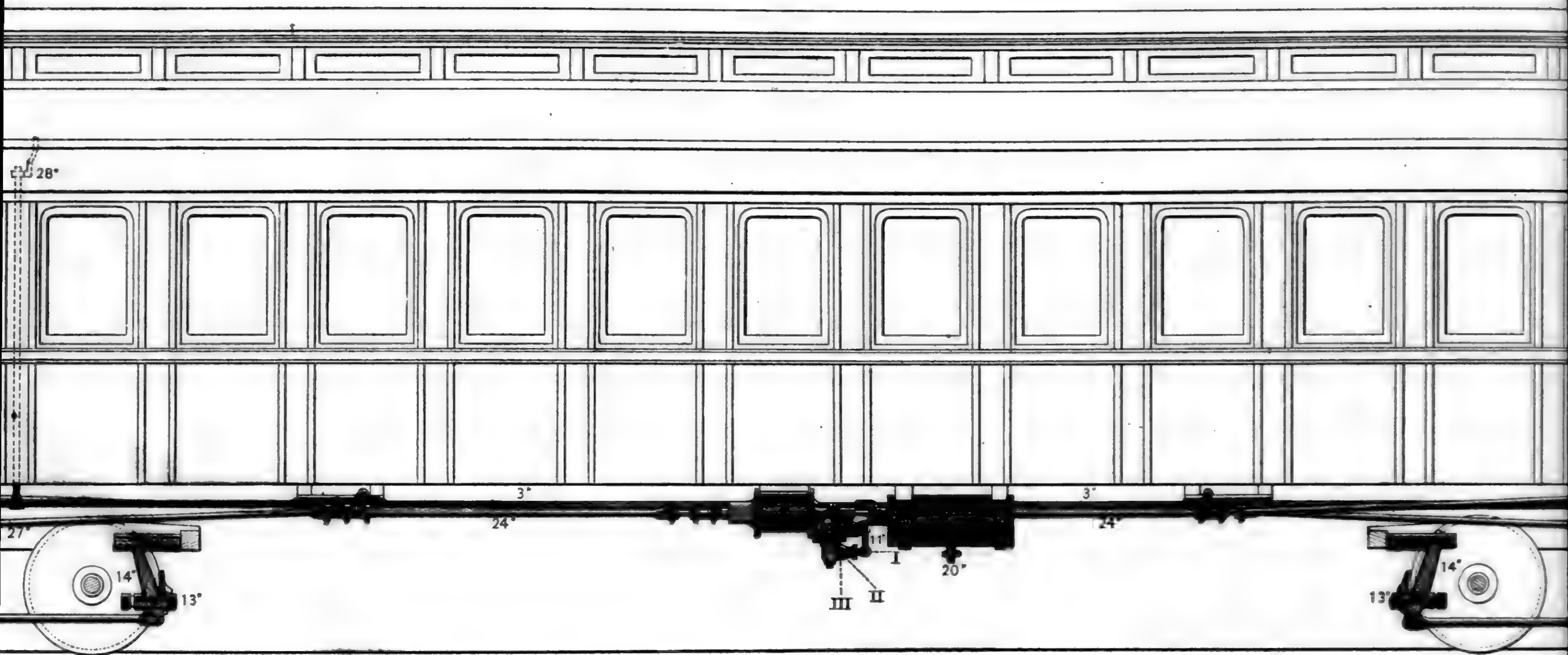
28"
3"
24"
27"
14"
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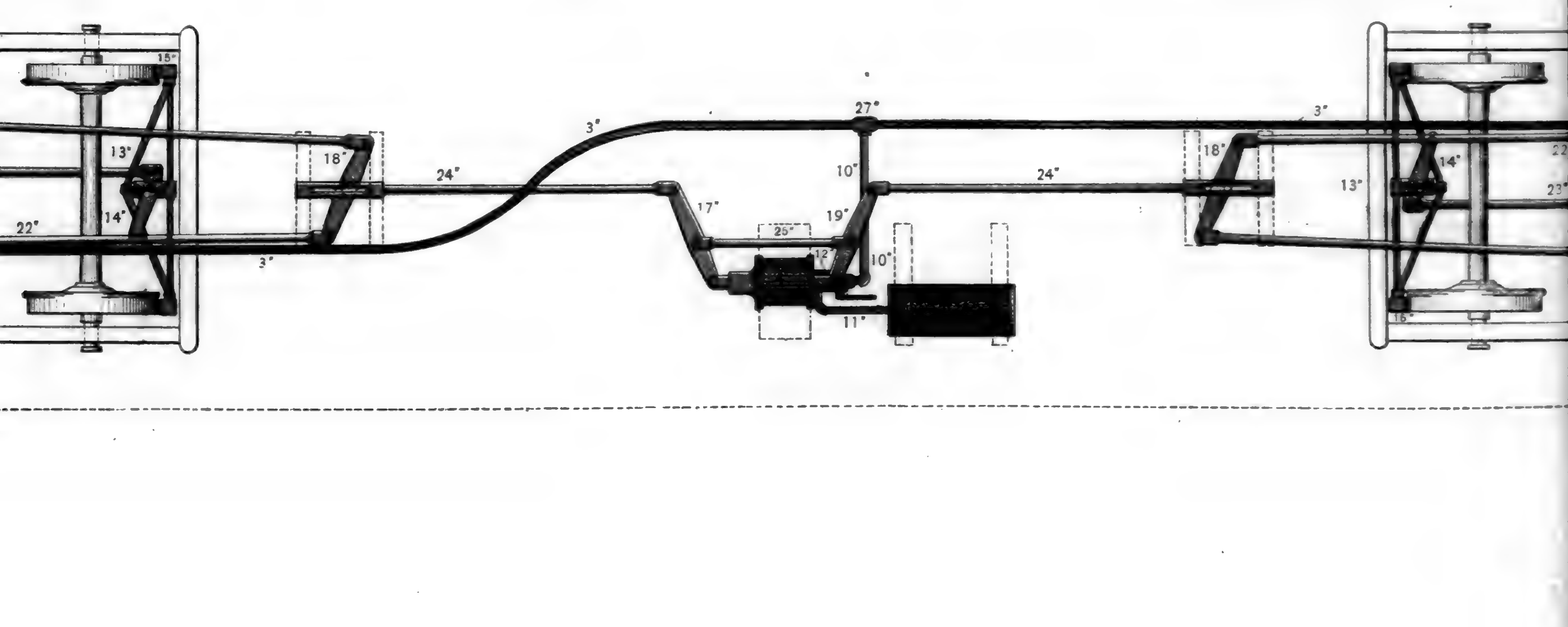
I
II
III
20"


15"
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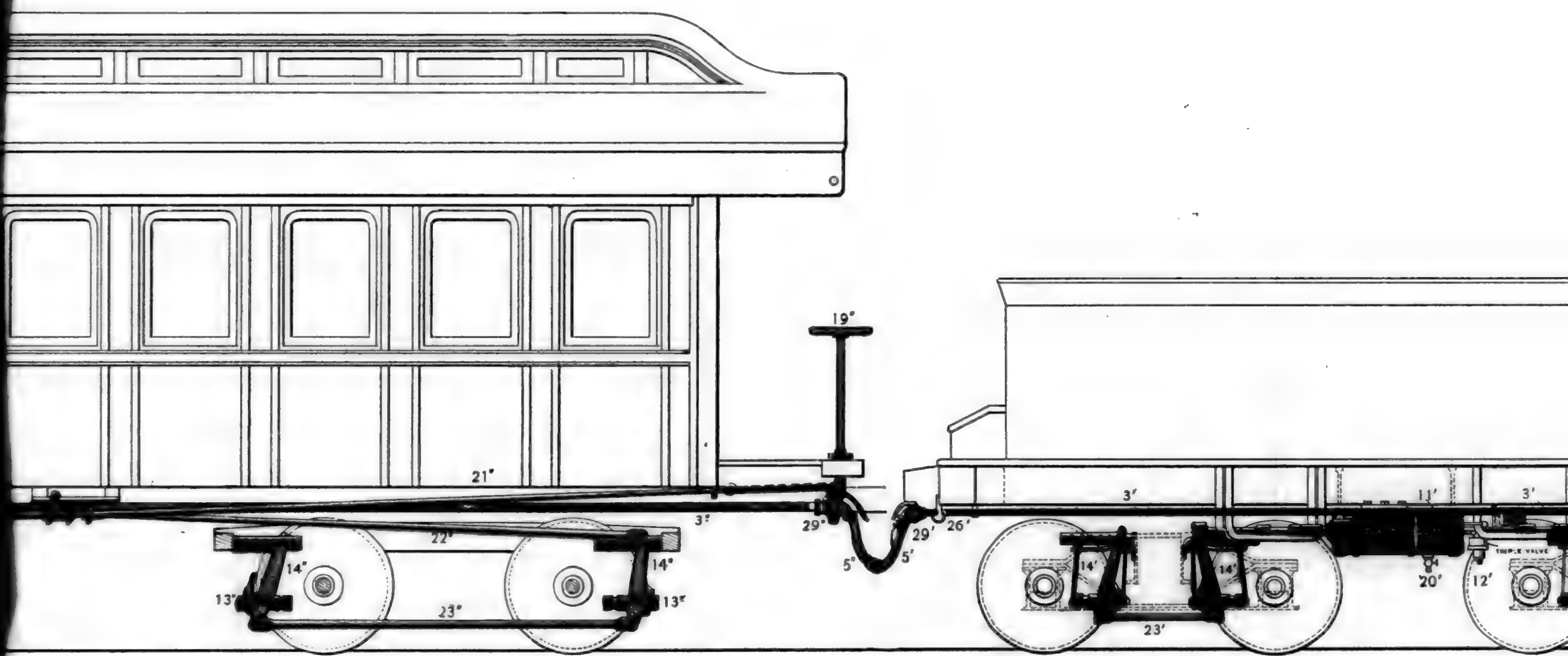
C

CATECHISM OF THE LOCOMOTIVE

Fig. A.



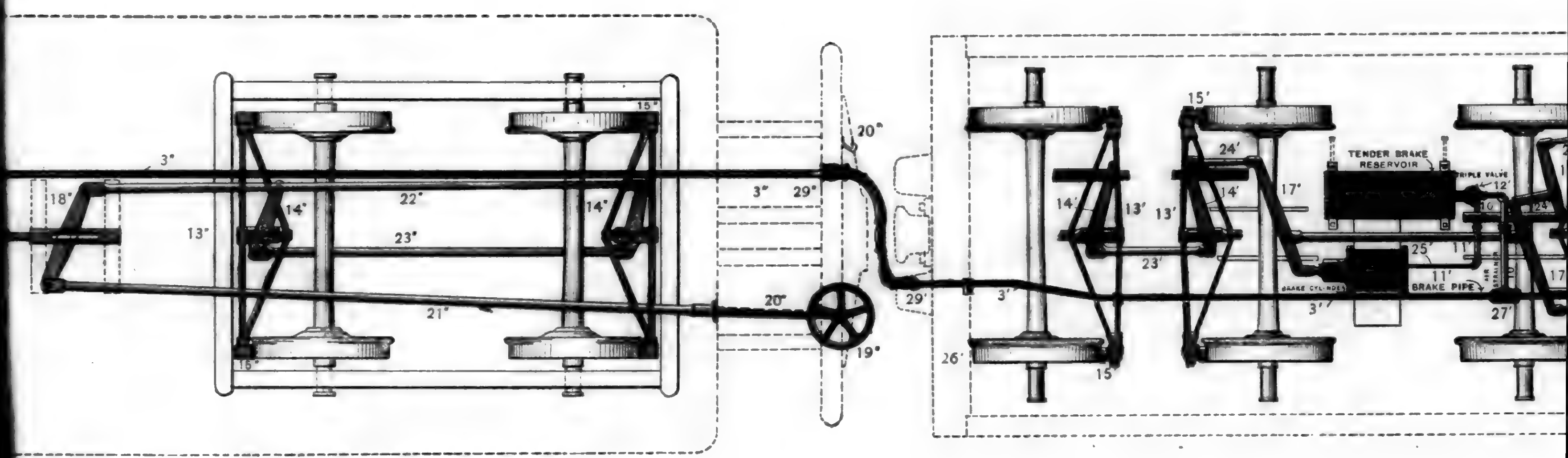
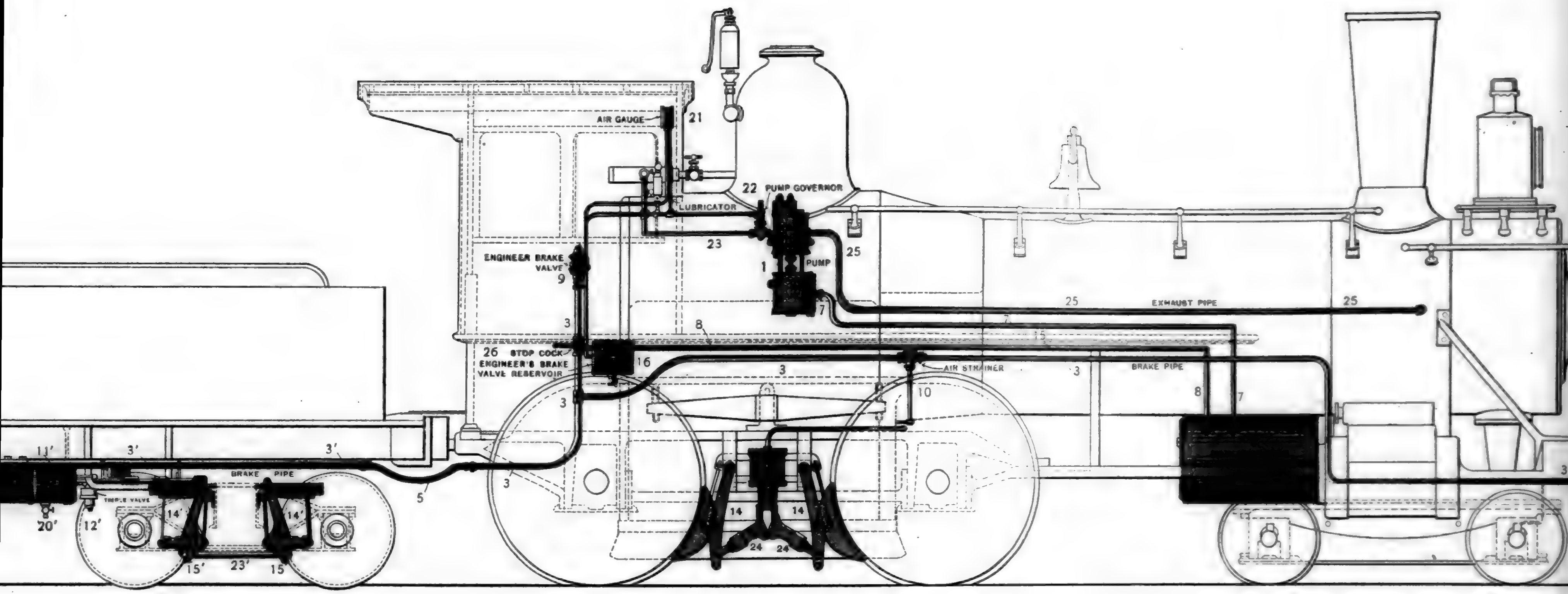
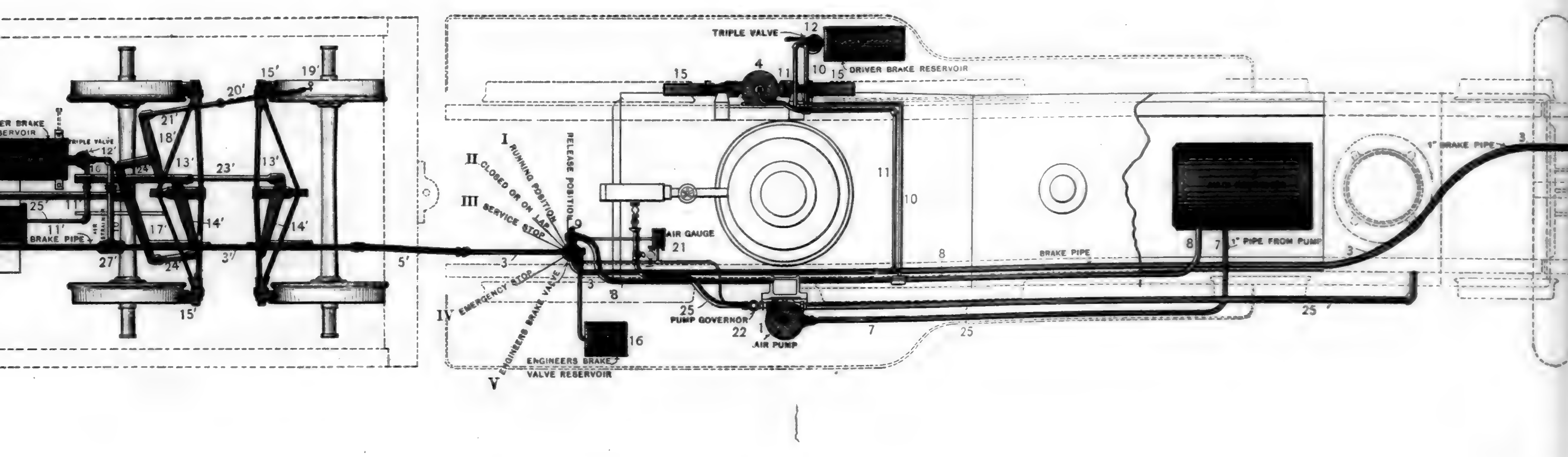


Fig. C.

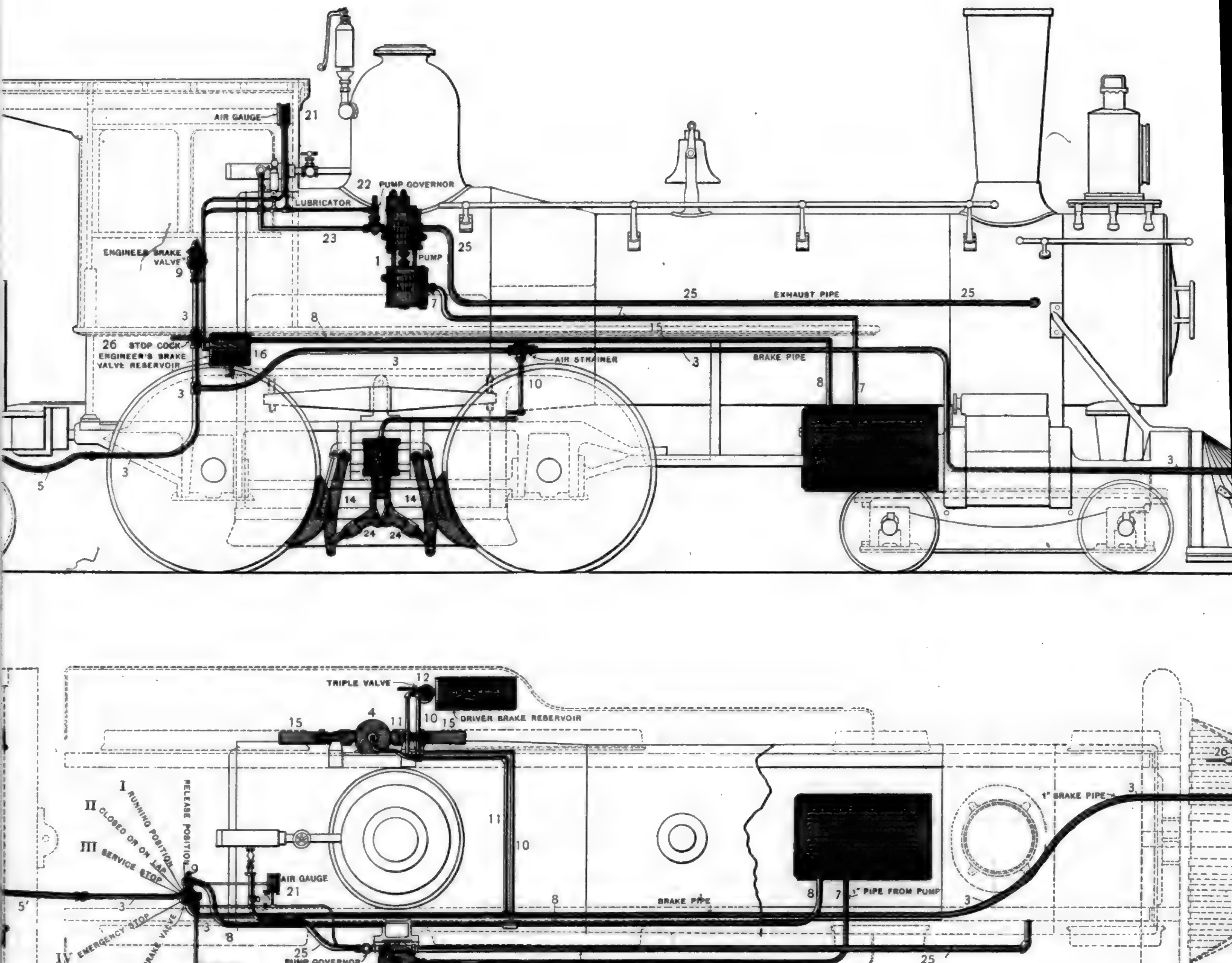
WESTINGHOUSE AUTOMATIC AIR BR

OTIVE

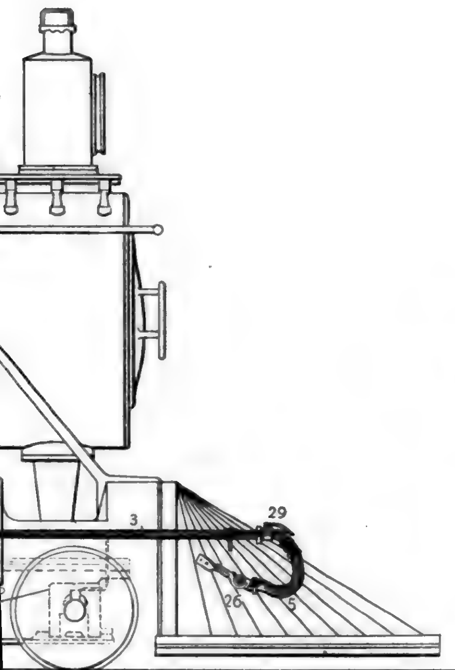




AIR BRAKE.



AIR GAUGE
21
22
PUMP GOVERNOR
LUBRICATOR
23
PUMP
25
1
ENGINEERS BRAKE VALVE
9
EXHAUST PIPE
7
8
15
26
STOP COCK
ENGINEER'S BRAKE VALVE RESERVOIR
16
3
AIR STRAINER
BRAKE PIPE
10
5
14
24
TRIPLE VALVE
12
4
11
DRIVER BRAKE RESERVOIR
1" BRAKE PIPE
I RUNNING POSITION
II CLOSED OR ON LAP
III SERVICE STOP
RELEASE POSITION
IV EMERGENCY STOP
V
ENGINEERS BRAKE VALVE
5'
AIR GAUGE
1" PIPE FROM PUMP
PUMP GOVERNOR
AIR PUMP
ENGINEERS BRAKE VALVE RESERVOIR


3
29
26
5

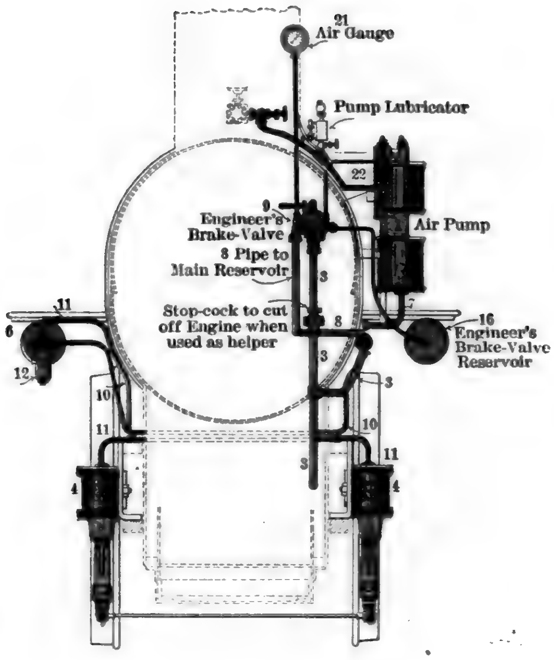
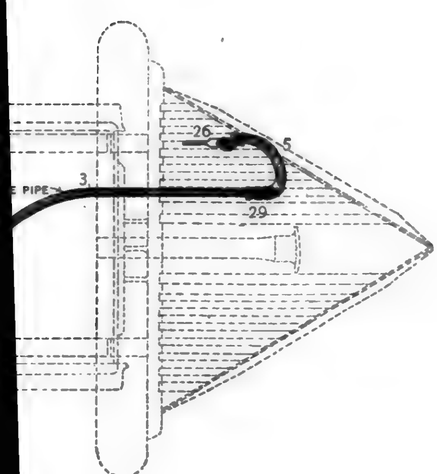

21
Air Gauge
Pump Lubricator
22
9
Engineer's
Brake-Valve
Air Pump
8 Pipe to
Main Reservoir
3
Stop-cock to cut
off Engine when
used as helper
8
11
6
12
16
Engineer's
Brake-Valve
Reservoir
10
11
3
10
11
4
4

Fig. B.


26
5
E PIPE
3
29

the weight of the machinery, we cannot increase the size of the boiler. Now, large wheels are heavier than small ones; they require larger cylinders, stronger connections, heavier frames, and in fact nearly all the parts of the machinery used with large wheels must be heavier than are required when small wheels are used. Therefore, by decreasing the size of the wheels all the other parts of the engine proper can be made lighter than is possible if large wheels are used, and thus the size and weight of the boiler can be increased without increasing the whole weight of the locomotive. There is, of course, a practical limit below which the size of the wheels cannot be reduced, because the speed of the piston would become so great as to be injurious to the machinery. By reducing the stroke, however, with the diameter of the wheels, the evil referred to may be obviated to a great extent. A cylinder with a large diameter and comparatively small stroke has also the advantage that there is less surface exposed to radiation of heat than there is in a cylinder in which these proportions are reversed.

CHAPTER XXV.

THE WESTINGHOUSE AUTOMATIC AIR-BRAKE.

QUESTION 630. *What are the brakes on locomotives, tenders, and cars for?*

Answer. The brakes are for the purpose of reducing the speed of such vehicles, or stopping them quickly when they are moving.

QUESTION 631. *How are brakes usually constructed and operated?*

Answer. The brakes which are most commonly used on railroads consist of metal or sometimes wooden shoes, which are attached to transverse beams, and suspended so that the shoes can bear or rub against the treads of the wheels. The beams are connected to levers, and the levers are connected together by rods and by a chain to a windlass, which is wound up by a crank or hand wheel, and the brake-shoes are thus pressed against the treads of the wheels, and the friction which is thus produced resists the motion of the vehicle and causes it to run slower or stops it.

QUESTION 632. *What difficulty is encountered in using brakes of this kind which are applied by hand?*

Answer. In cases of danger it takes too much time to apply such brakes. If a fast-running train encounters any obstacle or obstruction on the track the brakes cannot be applied quickly enough to stop the train in time to avoid an accident.

QUESTION 633. *What was the air-brake designed for?*

Answer. It was designed to apply brakes quickly by means of compressed air instead of hand power, and also to place the control of the brakes in the hands of the locomotive runner.

QUESTION 634. *How were the first air-brakes constructed?*

Answer. The first air-brakes designed by Mr. Westinghouse consisted of an air-pump, driven by steam, on the locomotive for compressing the air, and a reservoir on the engine or tender for holding the compressed air. The tender and each car had a cylinder and piston underneath its body, the pistons of which were connected to the brake-levers. Each car had a pipe, called a brake-pipe, extending its whole length and connected to the brake cylinder, the pipes on adjoining cars and the tender being connected together by flexible hose. The tender-pipe was connected to the air reservoir with a valve, by which communication could be opened or closed between the pipe and the reservoir. The latter was pumped full of air of a pressure of 30 or 45 lbs. per square inch. When it was desired to apply the brakes, communication was opened between the air reservoir and the train-pipe. The compressed air in the reservoir then flowed through the train-pipes to the cylinders and forced the pistons outward. The force exerted on the pistons was communicated to the brake-levers, thus pressing the brake-shoes against the wheels. This form of brake was named the "*straight*" air-brake by the men who used it.

QUESTION 635. *What difficulty was encountered in using this form of brake?*

Answer. If the train consisted of more than a few cars considerable time was required for the air to flow from the reservoir through the brake-pipes to the cylinders. When danger is imminent a very small fraction of time is of the utmost importance. It was therefore found that this form of air-brake would not act quickly enough in case of danger, and it was also found that in the event of the bursting of a coupling hose or brake-pipe, the supply of air to the cars behind the rupture was cut off and the air in the reservoir escaped, and the brakes would not work. As such ruptures were liable to occur at times when the brakes were most needed, it was a serious defect. It was also found that if a train broke in two that then the brakes could be applied to the front end of it and would stop it, whereas it had no control over the back portion, which was liable to run into the front part and thus cause a dangerous collision.

QUESTION 636. *How were these difficulties overcome?*

Answer. Mr. George Westinghouse, Jr., devised and in 1872 patented what is called the Automatic Air-Brake, and which is now generally used on passenger and to some extent on freight trains in this country.

QUESTION 637. *How is the automatic air-brake constructed?*

Answer. Its general arrangement is shown in Plate VI, which represents a side view and plan of a locomotive, tender, and car, and a view looking at the back end of the locomotive. The pipes and reservoirs are colored blue, and the other parts of the brake are colored red. In fig. A the running gear of the tender and car are shown in section, and in fig. B the bodies of the tender and car are supposed to be removed and are indicated by dotted lines only.

The automatic brake consists of the same parts as the first or "straight" air-brake had—that is, an air-pump, 1, figs. A, B, and C; a main reservoir, 2, a brake-pipe, 3 3, 3′ 3′, 3″ 3″, for conveying air from the main reservoir to the tender and each car behind it; cylinders and pistons, 4, 4′, 4″, on each vehicle of the train, which are connected to the brake-levers and brake-beams as shown, and as will be more fully explained further on. The brake-pipe has a flexible hose connection, 5, 5′, 5″, between adjoining vehicles which have suitable couplings for connecting and disconnecting the hose. Instead of having but one air reservoir on the engine or tender for holding compressed air, the automatic brake has separate or auxiliary reservoirs, 6, 6′, 6″, on the locomotive, the tender, and each car. The air-pump is connected to the main reservoir by a pipe 7, 7. The main reservoir is connected by another pipe, 8, 8, 8, to the engineer's brake-valve, 9. The brake-pipe 3, 3′, 3″ is connected to the engineer's valve and extends back under the tender and cars, and, as already explained, is connected together between the different vehicles by hose, 5, 5′, 5″, and to the auxiliary reservoir by pipes 10, 10′, 10″, and the auxiliary reservoirs are connected to the brake cylinders by other pipes, 11, 11′, 11″. The pipes 10, 10′, 10″ and 11, 11′, 11″ communicate with the auxiliary reservoirs through ingenious valves, 12, 12′, 12″, called triple-valves, whose construction and operation will be explained further on.

The cylinders have pistons which are connected to a system of brake-levers shown in the engravings. These levers are connected to the brake-beams 13, 13′, 13″, which have shoes on their ends that bear against the treads of the wheels.

QUESTION 638. *How does the automatic air-brake operate?*

Answer. Its operation is as follows: Before the train starts steam is let on to the air-pump, which then pumps or compresses air which passes into the main reservoir 2 through the pipe 7, 7. Communication is then opened by means of the engineer's valve between the pipe 8, 8, which is connected to the main reservoir and the brake-pipe 3, 3′, 3″.

The compressed air then flows from the main reservoir through the pipe 8, 8, engineer's valve 9, and brake-pipe 3, 3′, 3″, thence through the branch pipes 10, 10′, 10″ and triple-valves 12, 12′, 12″ to the auxiliary reservoirs. When the reservoirs and brake-pipe are filled with compressed air of about 70 lbs. pressure per square inch, the train is ready to start.

The triple-valves are constructed so that as long as the brake-pipe is filled with compressed air communication between the auxiliary reservoirs 6, 6′, 6″ and the brake-cylinders 4, 4′, 4″ is closed, but as soon as the pressure in the brake-pipe is reduced the triple-valves open communication between the auxiliary reservoirs 6, 6′, 6″ and the brake-cylinders 4, 4′, 4″ through the pipes 11, 11′, 11″. If, then, some of the compressed air in the brake-pipe is allowed to escape, and the pressure in it is thus reduced, the triple-valves will open, so that the air in the auxiliary reservoirs can flow into the brake cylinders, which will then force out the pistons and apply the brakes. The engineer's valve is constructed so that by turning a handle shown at 9 in the plan it allows the air in the brake-pipe to escape, which reduces the pressure in the pipe. To apply the brakes, then, all that the engineer must do is to turn the handle of the valve 9.

QUESTION 639. *After the brakes have been applied, how are they released?*

Answer. The handle of the engineer's valve 9 is turned so as to close the opening for the escape of the air from the brake-pipe, and at the same time communication is made between the main reservoir and the brake-pipe. The compressed air stored in the main reservoir then flows into the brake-pipe, which closes the triple-valves, and at the same time they allow the air in the cylinders to escape, and a spring in the pistons forces them inward and releases the brakes.

QUESTION 640. *In practice what is essential in applying automatic brakes?*

Answer. In case of danger it is essential that the brakes should be applied as quickly as possible, and it is also important that the engineer should be able to apply them either gradually

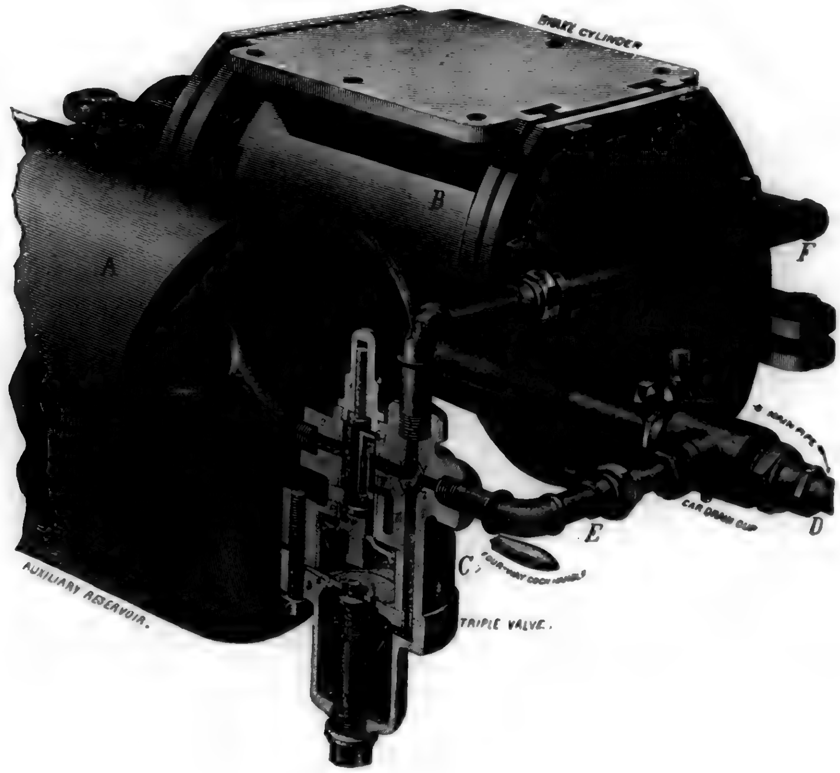


Fig. 368.

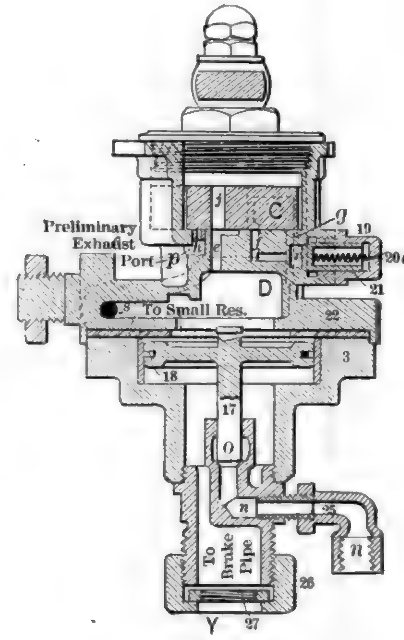


Fig. 373.

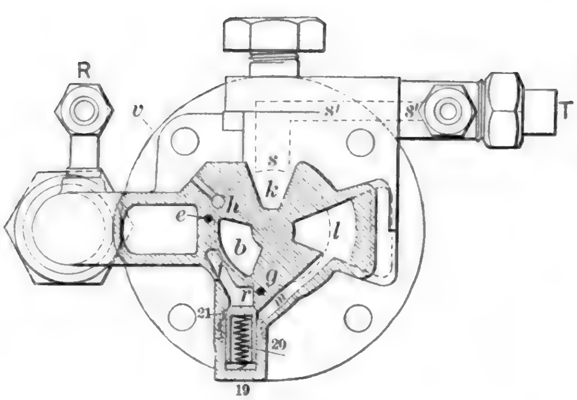


Fig. 374.

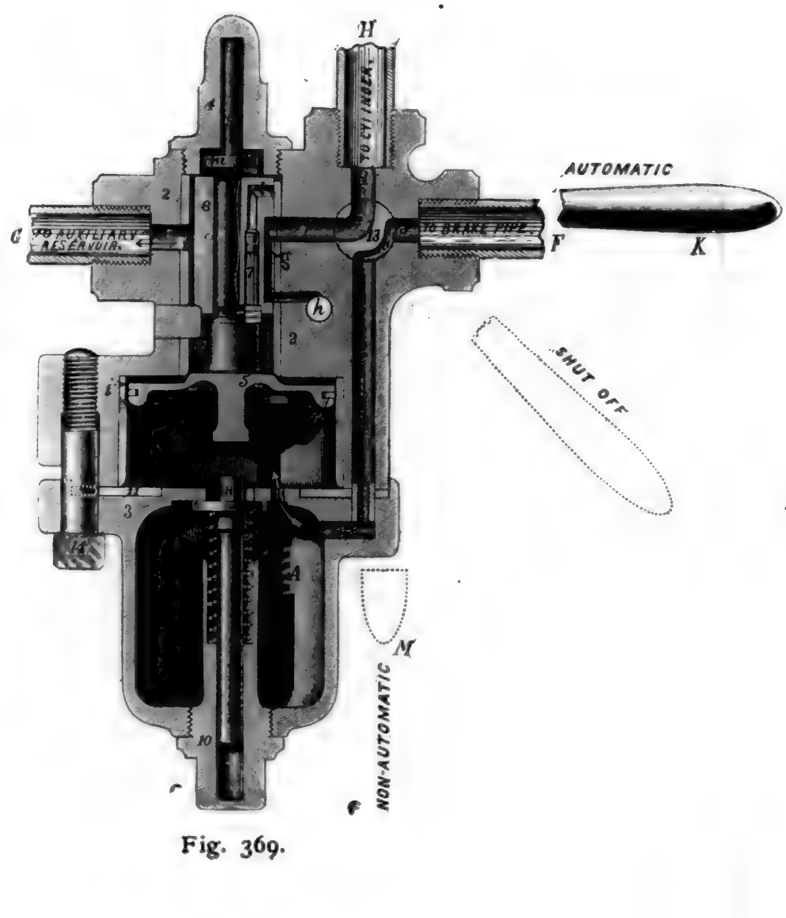


Fig. 369.

or as rapidly as circumstances may require—in other words, that he should be able to regulate the pressure on the brake-shoes to stop slowly or quickly, or to increase or diminish it at pleasure, or at times release the pressure on the wheels instantly.

QUESTION 641. *What is meant by the automatic action of the brakes?*

Answer. It has been explained that when the pressure of the air in the brake-pipe is reduced, that the triple-valves open communication between the auxiliary reservoirs and the brake cylinders so that the compressed air in the reservoirs then flows into the cylinders and applies the brakes. If therefore a coupling hose should burst or a train break in two, or any other accident should occur so that the compressed air in the brake-pipe would escape, the brakes would go on of themselves, or be applied *automatically*.

QUESTION 642. *On what does the automatic action of the brakes depend?*

Answer. Chiefly in the triple-valves and their connection with the auxiliary reservoirs and the brake-cylinders. Fig. 368 is a perspective view, and shows one end of the auxiliary reservoir *A*, the cylinder *B*, with the triple-valve *C* shown in section. *D D* is the brake-pipe, to which the triple-valve is connected by the pipe *E*. It is also connected to the cylinder *B* by the pipe *F F*, and to the auxiliary reservoir by the connection 2.

QUESTION 643. *How is the triple valve cons'ructed, and what is its operation?*

Answer. Its construction is shown in fig. 369, which represents a section of the valve. It consists of a piston, 5, which works in the cylindrical chamber *B*. The rod or stem of this piston engages with a slide-valve, 6. When the engineer's valve is turned so that there is communication from the main reservoir through the valve to the brake-pipe, the air from the reservoir enters the triple-valve at *F*, passes through the four-way cock 13 by passages *a b c* and drain-cup *A* to the cylinder *B*, forcing the piston 5 into its normal position as shown in the engraving. The air then flows through a small groove—shown at *i* on the left-hand side of the piston—past the piston into the valve chamber *C* above it, and through the passage *C k* and pipe *G* into the auxiliary reservoir, while at the same time there is an open communication from the brake-cylinder to the atmosphere through the pipe *H* and passages *d e f g h*. Air will thus continue to flow into the auxiliary reservoir until it is filled with air of the same pressure as that in the brake-pipe.

If now the air in the main brake-pipe *F* is allowed to escape by means of the engineer's valve, or through accident, such as the bursting of a hose, the pressure of the air in the brake-pipe *F* and chamber *B*, below the piston 5, will be reduced, whereupon the greater pressure in the auxiliary reservoir and above the piston 5 will force it downward past the groove at *i* and close it. As the piston descends it moves the slide-valve 6 with it and uncovers the passage *f* so as to permit air to flow directly from the auxiliary reservoir through the pipe *G*, passages *k f e d* and pipe *H* into the brake-cylinder, which applies the brake.

To release the brakes, air from the main reservoir must be admitted, by means of the engineer's valve, into the main brake-pipe from the main reservoir. As the pressure in the main reservoir is greater than that in the auxiliary reservoir, it forces the piston 5 and slide-valve 6 back to the position shown in the engraving, which allows the air in the brake-cylinder to escape through the pipe *H* and passage *d e f g h*.

To apply the brakes gently, a slight reduction is made in the pressure in the main brake-pipe, which moves the piston down slowly. The slide-valve 6 has a conical valve, 7, called a *graduating valve*, which closes the passage *l*. A pin, *n*, in the piston-rod engages with the valve 7, so that when the piston first begins to move downward it pulls the valve 7 with it and opens the passage *l*. As the piston moves further the collar *m* engages with the slide-valve and carries it downward with it until the port *l* is over the passage *f* and the piston 5 comes in contact with the graduating stem 8 and spring 9. Air from the auxiliary reservoir then flows through holes (shown by dotted lines above 7) in the side-valve, and passes by the passages *l f e d* to the brake-cylinder. When the pressure in the auxiliary reservoir has been reduced, by expanding into the brake-cylinder, until it is of the same pressure as that in the main brake-pipe, the graduating spring 9 pushes the piston up far enough to close the small valve 7. This causes whatever pressure there is in the brake-cylinder to be retained there, thus applying the brakes with a force proportionate to the reduction of pressure in the brake-pipe. It will thus be seen that it is important to be able to regulate and control the pressure in the main brake-pipe. This is done by means of the engineer's brake and equalizing discharge-valve.

QUESTION 644. *What is the four-way cock* 13, *fig.* 369, *for?*

Answer. This cock is used to shut off the brake cylinder and auxiliary reservoir with which it is connected, if from any cause it is desirable to have the brake on any particular car inoperative. To do this the handle *K*, which is connected to the plug 13, of the cock is turned from a horizontal position, *K*, to an intermediate one, shown by the dotted lines. This leaves the main brake-pipe unobstructed to supply air to the other vehicles in the train. If the handle *K* of the cock is turned down to the position indicated by the dotted lines at *M*, there is then a direct communication from the main brake-pipe to the brake-cylinder through a channel *a e d*—the triple-valve and auxiliary reservoir being cut out—and the apparatus can be worked as a non-automatic brake by admitting air into the main brake-pipe and brake-cylinder to apply the brakes.

QUESTION 645. *What is the lower chamber A for?*

Answer. This is called a *drain-cup*, and its object is to collect any water which may accumulate in the pipes. The water can be removed by unscrewing the plug 10 in the bottom of the cup.

QUESTION 646. *Why is it essential to have an excess of pressure in the main reservoir over that in the main pipe and auxiliary reservoirs?*

Answer. When the brakes are applied, as has been explained, the piston 5 in the triple-valve, fig. 369, is forced down in the cylinder *B*. To release the brakes this piston must be forced up in the cylinder to the position shown in the engraving. To do this promptly and with certainty it is absolutely essential in long trains, and is of great importance in short ones, to have an *excess* of pressure in the main reservoir, so that when air is admitted to the brake-pipe the pressure below the pistons in the triple-valves will be considerably greater than that above it. If it is not considerably greater it may not raise the pistons into the position they must occupy to release the brakes. The method of increasing the pressure in the main reservoir will be explained further on.

QUESTION 647. *How is the engineer's brake and equalizing discharge valve constructed, and how does it operate?*

Answer. The construction of this valve is shown in figs. 370 to 378, fig. 370 being a vertical section on the line *I t* of fig. 371, which is a plan with the valve 13 removed, and fig. 373 a similar section on the irregular line *v h e f r* 19 of fig 374; fig. 374 a horizontal section on the line *p q* of 370. The pipe *X* connects with the main reservoir, and *Y* with the brake-pipe. Fig. 372 is a plan of the rotary valve 13. This valve has an opening or "supply port," *a* (shown also in fig. 370), and a cavity, *c*, in its under side analogous to the exhaust cavity in an ordinary slide-valve. This cavity is represented by dotted shade lines in the plan, and also in figs. 375 to 378. The valve also has another small port, *j*, which passes entirely through it—as shown in fig. 373—and a small cavity, *p*, also indicated by dotted shade lines in the various plans.

Fig. 375 represents a plan of the rotary valve 13 on its seat, in the position it would be placed to release the brakes, and where it would be left when the engine has completed its run. To prepare for another run, steam is turned on and the air-pump is started, which forces air into the main reservoir, which is connected to the engineer's valve by the pipe *X*, fig. 370. When the rotary valve is in the position shown in fig. 375 the *supply-port a* in the valve is over the cavity *b* in the valve-seat. This cavity is also shown in figs. 370 and 371, and in figs. 375 to 379 the part which is uncovered by the port *a* is represented by black shading, and that which is covered by the valve is shaded with round dots. When the valve is in the position shown in fig. 375 the cavity *c* in its under side is over the supply cavity *b* and also over the port *l*, which communicates with the main-brake-pipe, as shown in fig. 370. When the valve is in the position shown air can flow from the main reservoir up through the pipe *X*, fig. 370, into the supply port *a*, in the valve, and into the cavity *b* in the valve-seat, then up into the cavity *C* in the under side of the valve, and from there down into the direct application and supply port *l l*, which communicates with the main brake-pipe *Y*, from which it passes to the triple-valves and through them to the auxiliary reservoirs. When the rotary valve is in this position, the port *j* in the valve is over the port *e* in the seat, which is connected with the chamber *D*, as shown by dotted lines in fig. 370. Air from the main reservoir can therefore flow into the chamber *D* above the piston 17, and thence through the port *s*, which communicates with the pipe *T* (as shown by dotted lines *s*, *s'*, *s'*, fig. 374), and thence to a small reservoir, 15, Plate VI, that is usually suspended under the running board of the engine. The purpose of this reservoir is to add to the volume of the chamber *D*.

When the auxiliary reservoirs are filled with compressed air the rotary-valve is then turned to the II position, or "*while running*" position, shown in fig. 371 and 377. In this position communication between the supply port *a* in the valve and the port *l* in its seat is closed. A small hole, *j*, in the valve then comes over the small feed-port *f* in the seat, which is connected

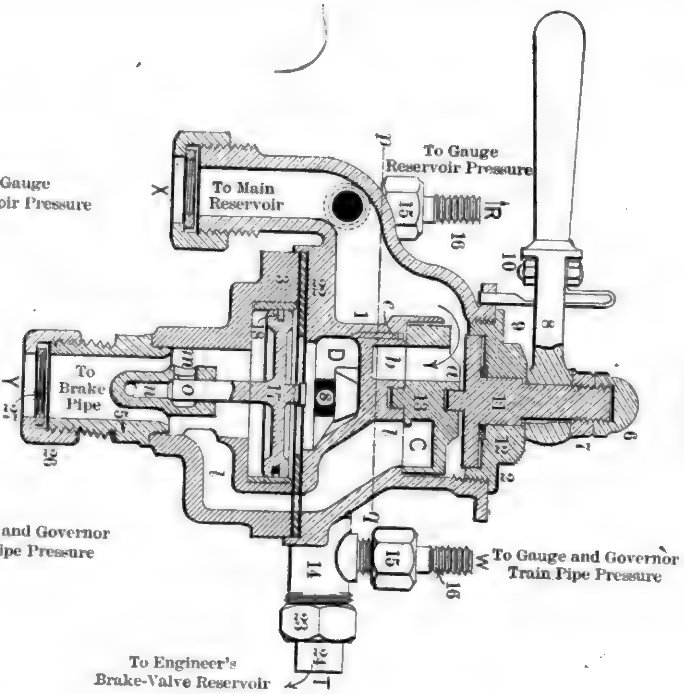


Fig. 370.

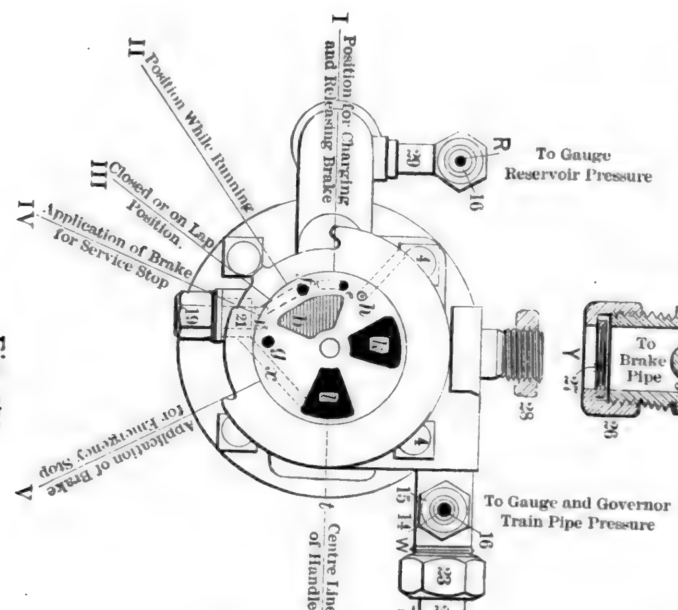


Fig. 371.

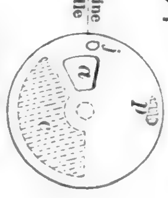


Fig. 372.

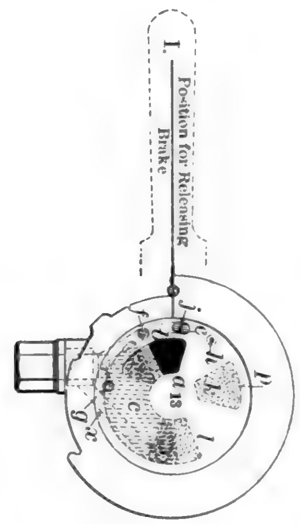


Fig. 375.

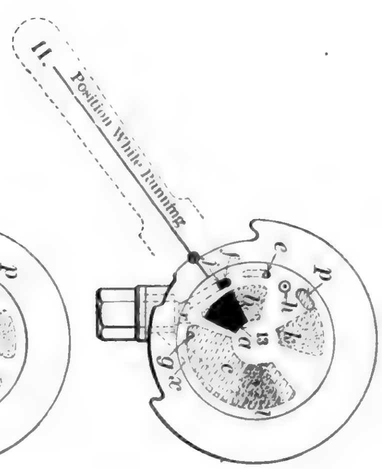


Fig. 376.

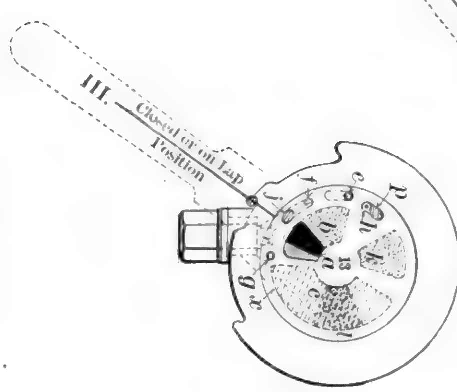


Fig. 377.

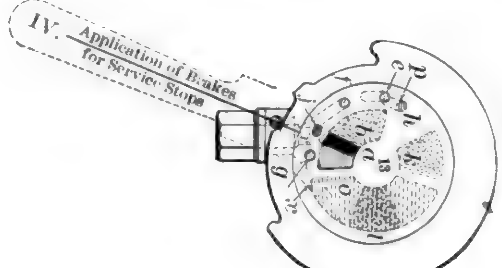


Fig. 378.

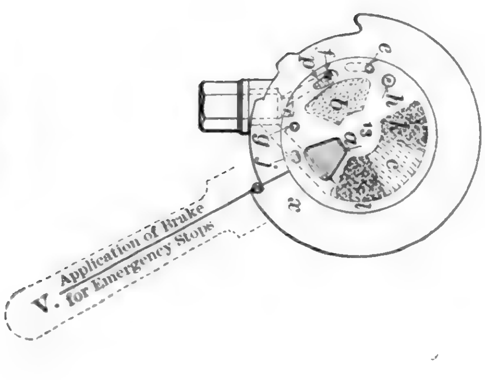


Fig. 379.

to the cavity *r* under the "*feed-valve*" 21, as shown in figs. 371 and 374, so that air can then flow from the main reservoir through the brake-pipe *X*, port *f*, and passage *f* into the cavity *r*. The feed-valve is pressed down on its seat by a spiral spring, 20, figs. 373 and 374, which has a resistance equivalent to a pressure of air of about 20 lbs. per square inch. When this additional pressure is accumulated in the main reservoir the feed-valve is forced open, and the air which escapes passes through the "feed-port" or channel *m*, fig. 374, to the port *l*, and thence to the brake-pipe *Y*, fig. 370. At the same time air can pass from the port *l*, see fig. 376, into the cavity *c* under the valve, and thence down through the equalizing port *g*, in the valve-seat, which, as shown in fig. 373, communicates with the cavity *D* above the piston 17. The same pressure is therefore maintained in the chamber *D* that exists in the feed-port, so that the pressure above and below the piston is thus equalized. The stem *o*, fig. 370, of the piston forms a small conical valve which is seated above the passage *n*, and closes it when down. The passage *n* communicates with the atmosphere—see fig. 373—so that if the piston is moved upward and opens the valve, it allows air in the brake-pipe to escape. It will thus be seen that when the rotary-valve is in position II, fig. 376, that the same pressure is maintained in the chamber *D*, fig. 370, that exists in the brake-pipe. When the valve is in this position no air can pass from the main reservoir to the brake-pipe until its pressure is sufficient to open the feed-valve 21, which requires a pressure of 20 lbs. per square inch. As the pressure in the brake-pipe is exerted against the opposite side of the valve 21, it will require an excess of pressure of 20 lbs. in the main reservoir over that in the brake-pipe before the valve 21 will be opened, and when it does open air from the main reservoir will flow through the pipe *X* (see figs. 371 and 374), port *j*, passage *f*, into the cavity *r*, and thence through the feed-port *m*, and thence into the cavity *l l* and brake-pipe *Y*. Consequently when the rotary-valve is in the position II, the pump will fill the main reservoir with air of a pressure 20 lbs. greater than that in the brake-pipe, the object of which has already been explained.

To apply the brakes for making ordinary stops at stations, or service stops, as they are called, the handle 8 of the rotary-valve is turned into position III, figs. 371 and 377. When in this position all communication through the valve and its seat is closed. The valve handle should then be moved to the IV position, or that for the "application of brakes for service stop." A small exhaust cavity, *p*, figs. 372 and 377, on the under side of the rotary-valve 13 then establishes communication between the two "*preliminary exhaust-ports*" *e* and *h*, figs. 371 and 377, in the valve-seat. The first of these, *e*, connects with the chamber *D*, as shown in fig. 373, and the second, *h*, leads to the atmosphere (see fig. 374). Air can therefore escape up from the chamber *D*, see fig. 370, through the passage *e*, cavity *p*, and down the passage *h* to the atmosphere. It will be remembered that the chamber *D* is connected by the passage *S* and pipe *T*, figs. 370 and 374, with the brake-valve reservoir 15, Plate VI. A pressure-gauge, 23, Plate VI, is connected by a pipe, 24, 24, to the branch *W*, fig. 370, which communicates with the chamber *D*.

The gauge 23 has two sets of works in it, one of them connected as described, and the other connected by a pipe, 25, 25, Plate VI, to the pipe which leads to the main reservoir. The two hands of the gauge thus indicate the pressure in the main reservoir and also in the chamber *D*.

In making an ordinary stop, after the pressure in *D* has been reduced about 8 lbs., the handle of the engineer's valve should be restored to the III, or closed position. This reduction of pressure in *D* will cause the air below the piston 17, fig. 370, to force it and its stem upward, which will open the valve at *o* and allow air in the brake-pipe *Y* to escape to the atmosphere through the ports *m* and passage *n*, thus applying the brakes gently. This discharge of air continues after the valve handle is carried to the III or "closed" position—which allows the pressure in the brake-pipe to gradually equalize itself through the whole length of the train—and the escape of air from the brake-pipe does not cease until the pressure in it has been reduced slightly lower than that yet remaining in the chamber *D* above the piston. The latter is then forced downward, which closes the outlet at *o* and prevents the further escape of air, until the operation is repeated, which may be necessary to apply the brakes with the desired force.

QUESTION 648. *What difficulty in the application of brakes is the feature of the engineer's brake and equalizing valve, which has been described last, intended to overcome?*

Answer. In applying the brakes, especially on long trains, if the engineer, instead of allowing the air to escape slowly from the brake-pipes, allows a considerable amount of air to escape in a short time and then closes the valve suddenly, the air is exhausted from the front end of the brake-pipe which applies the brakes on the front cars before the pressure in the pipe has equalized itself. The air in the back end of the pipe then rushes forward, and if the valve has been closed suddenly this rush of air acts on the triple-valves and is liable to release the brakes on the front cars. To avoid this difficulty, the opening of the passage *h*, figs. 371 and 373, in the valve-face is made extremely small, and the chamber *D* is connected with the brake-valve reservoir, 15, Plate VI, so as to increase the volume of air which must be discharged before the brakes are applied. As soon as the pressure above the piston 17 is reduced lower than that below it, in the brake-pipe, the piston moves upward slowly and opens the valve *o*, which permits the air in the brake-pipe to escape through the opening *n*, fig. 373. This discharge of air continues after the rotary-valve 13 has closed the opening for the escape of air from the chamber *D*, and does not cease so long as there is any difference in the pressure above and below the piston, and until the pressure in the brake-pipe has been equalized and reduced slightly lower than that yet remaining above the piston. So long as there is more pressure below the piston than above it the valve *o* remains open, and is closed very gradually as the pressure in the brake-pipes is reduced. This, as has been explained, permits the pressure in the brake-pipe to become equalized and secures a uniform application of the brakes through the whole length of the train.

When the pressure in the brake-pipe is reduced a little below that above the piston the latter is forced down, and closes the valve *o*, which prevents the further escape of air until the rotary-valve handle is again moved to the IV position, fig. 378, and the operation is repeated.

QUESTION 649. *How are the brakes released?*

Answer. The rotary-valve handle 8, fig. 376, is turned back to the I position, or that "for releasing brakes," shown by figs. 371 and 375. This, as already described, allows air from the main reservoir to flow up through the pipe *X*, down through the port *a*, in the rotary-valve, into the cavity *b* in the valve-seat, and from there up into the cavity *c* in the under side of the valve, and thence down into the passage *l l* and to the brake-pipe *Y*. The pressure in the latter, as has been explained, acts on the triple-valve, which closes communication between the auxiliary reservoirs and brake-cylinders, and allows the air in the brake-cylinders to escape.

QUESTION 650. *In case of imminent danger or any emergency, how is the brake operated?*

Answer. In such an event it is, of course, essential to apply the brakes as quickly and as forcibly as possible. To do this the handle 8 of the rotary-valve is moved to the V or "emergency stop position," figs. 371 and 379. The chamber *c* in the under side of the rotary-valve then comes over the port *l* in the seat, which connects with the brake-pipe and also with the port *k*, which communicates with the atmosphere. This establishes direct communication between the train-pipe and the open air, and permits the air in the brake-pipe to escape quickly through the large openings of the ports referred to.

(TO BE CONTINUED.)

Manufactures.

Manufacturing Notes.

THE Dow Positive Piston Pump, which is now being introduced by the Kensington Engine Works, Philadelphia, is meeting with a very favorable reception and excellent reports are made of its performance. The first large one which was built —16 in.—has been in use at Elkton, Md., for two years past, giving much satisfaction; it is at work filling a reservoir and has required no attention but to keep the journals lubricated, and the Superintendent reports great economy in power. Recent sales include two pumps to the Remington Paper Mills, Watertown, N. Y., for high and low duty, including fire service, one of which is already in satisfactory use; a pump to supply a reservoir for Joseph Bancroft & Sons, Wilmington, Del., with 120 ft. lift, through 6-in. and 8-in. pipe; a pump for Callaghan Brothers' Cotton Mills, Philadelphia, with lift of 70 ft. through 600 ft. of 6-in. pipe; two pumps for the Quaker City Dye Works, one already in satisfactory use and the other with direct attachment to engine; also pumps for the Jessup & Moore Paper Company, the American Wood Paper Company, the Oneida Knitting Mills, and other parties. This pump was illustrated and described in the JOURNAL for December last.

THE Keystone Seal & Press Company, New York, has recently filled orders from a number of different roads for its car-lock and seal. These orders include one for a railroad in Guatemala.

THE Chicago, Milwaukee & St. Paul Railroad has had two of its through trains lighted with the electric light, the electricity being furnished by a dynamo in the baggage car; incandescent burners are used. These trains run between Chicago and Omaha.

THE Transcontinental Car-Lock & Seal Company in Chicago, has elected John W. Norris, President and Treasurer; Warren G. Purdy, Vice-President; J. Edwards Fay, Secretary; Charles E. Davis, Superintendent.

A PRETTY severe test of steam heating was recently experienced on the train known as the "Golden Gate Special," running between Omaha and San Francisco. During part of the trip the temperature was 32° below zero, and for a considerable distance west of Ogden 20° below. From this temperature the train, as it approached the western end of its trip ran into weather 60° above zero. The trainmen and passengers, however, report that the temperature of the cars was comfortable throughout the journey. This train is heated by the McElroy apparatus, manufactured in Detroit.

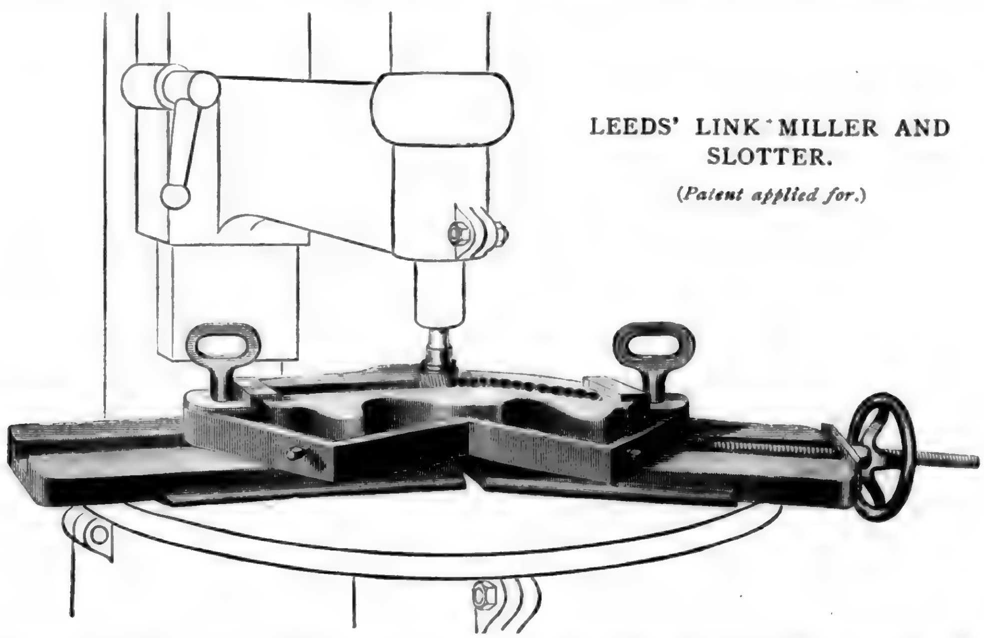
New Special Tools.

THE accompanying illustrations show two special tools recently introduced, which seem to be valuable additions to machine-shop plant.

The first is Leeds's link miller and slotter, which is intended to mill out links to any desired radius. It is designed on the principle that the apex of any angle will touch or describe all parts of a circle whose versed sine is equal to the perpendicular where the base is formed by the chord of the arc. It can be used on a good strong drill press, and will do excellent work. It can also be used as an attachment to a universal milling machine. It consists of a jointed frame having dove-tailed slots running lengthways to carry a frame that has the link blank secured in it, this frame is actuated by the screw and hand-wheel and describes a circle, according to the angular position of the lower or jointed frame; flanges are cast on the bottom of this frame for the purpose of bolting down on the table or platen. In the center of the lower frame, at the center of the joint, is a bronze bushing that is set exactly under the center of the drill-press spindle; this serves as a lower support for a boring bar and the shank of the milling-tool arbor. In practice it is found more convenient to drill a hole in one end of the link to be slotted, large enough for a boring bar to pass through, then by using a double-end cutter the slot is cut out to nearly the finished size; the link is then moved along ⅜ or ½ in. and is cut through again until the stock is removed; a milling cutter similar to a reamer is then used and the slot is finished to the radius for which the link is set. With this attachment a link 20 in. long is finished in about four hours. Directions for setting and operating are furnished for any particular case, and cutters or boring bars, milling cutters, arbors and mills made to order.

The second machine illustrated is Leeds's horizontal and radial drilling machine, which is designed to work on or from a drill press. It is mounted on the frame and is driven direct from the drill-press spindle. It is useful in drilling the ends and diagonal parts of locomotive frames; it can also be mounted on the work and driven by a sliding shaft and universal joints. Drilling in all directions can be done with the two taper shanks and the horizontal and vertical movements, by loosening the nuts shown. This machine does away with the expensive ratchet worked by hand, and it is capable of drilling with as great speed as though drilled direct.

Both of these machines were invented by Mr. P. Leeds, Master Mechanic, Louisville & Nashville Railroad, and are manufactured by Pedrick & Ayer, Philadelphia.



LEEDS' LINK MILLER AND SLOTTER.

(*Patent applied for.*)

Electric Notes.

THE *Electrical Engineer* gives the following summary of the total number and mileage of street railroads operated by electric motors in this country:

	In operation.	Building.
Number of roads	58	33
Total mileage worked	308	220
Number of motor cars	424	267

This list includes several roads on which electricity has been only partially adopted, and on which horses are still in use for some of the cars.

IN the equipment of the electric railroad at Atlantic City, N. J., the trolley wire will be of the small size, no larger than an ordinary telephone or telegraph wire, which is used on all the Sprague roads, and which is characteristic of that system. The material of the trolley wire will be of silicon bronze, and its high tensile strength, over 80,000 lbs. per square inch, will enable the overhead system of supports to be of the lightest and most unobtrusive character possible. This trolley wire will be re-enforced by the regular system of a main conductor running parallel, according to the Sprague method, and tapped at necessary intervals along the line to insure a uniform pressure of electricity at all points of the road. This main conductor is also re-enforced by feeders running directly from the generating station, so that the size and weight of all the overhead work is reduced to a minimum.

Each car will be equipped with two 15 H.P. Sprague improved motors, flexibly suspended to insure against accidents from sudden strain in starting and stopping. The cars will be lighted by electricity, protected by improved lightning arresters, and will be of the finest construction and workmanship. Having a capacity of 30 H.P. upon each, they will be able, if necessary, to run at the rate of 15 miles per hour, drawing two loaded cars, and can handle any load which it is possible to put on them.

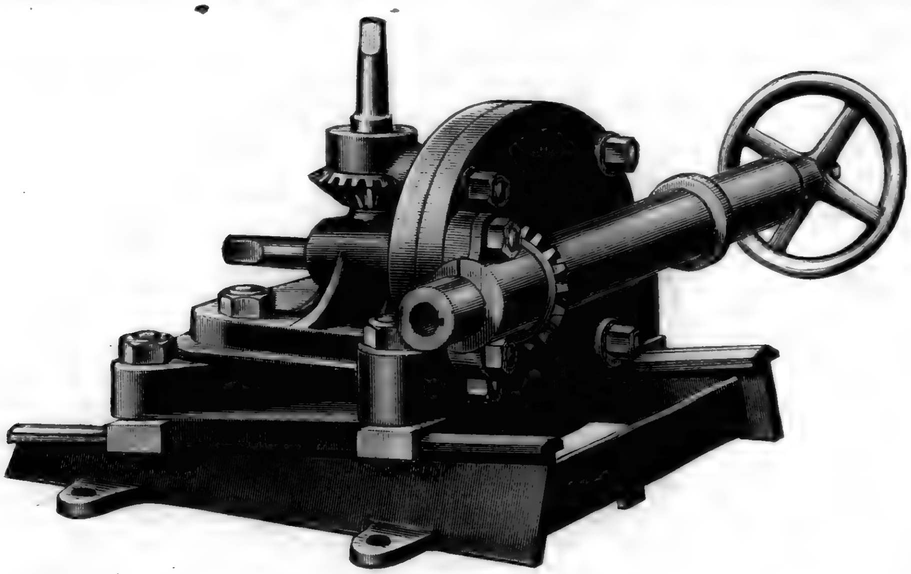
It is estimated that these electric cars will prove a great attraction to the many visitors at Atlantic City during the summer, and the most complete and expensive car equipments have been adopted in order to handle the large traffic. The first order for car equipments calls for 15 cars with overhead system and power station, but it is expected that this equipment will be increased before long.

The work on the overhead system for this railroad will be commenced as soon as possible, and it will not be long before

it is expected that the road will be in operation.—*The Electrician.*

The Westinghouse Friction Buffer.

A TRIAL of this buffer was recently made at the Pennsylvania Railroad car shops at Altoona, to determine the effect of the buffers when applied to freight cars, as well as the relative endurance of the buffers and the freight cars themselves. Two Pennsylvania Railroad gondola cars had been fitted with friction buffers for the purpose of this test. The cars were old and weak, and it was intended that the test should be so severe as to make them unfit for further service. The tests were conducted as follows: The two cars were set on a piece of straight track and the brakes on one firmly set; an engine hauled the other back and then gave it a shot down the track, so that it came into collision with the standing car. Fourteen such tests were made. In the first the moving car had a speed of about five miles per hour; in the successive tests, up to and including the eleventh, the speed was gradually increased, until, in the eleventh test, it reached 25 miles per hour. In the twelfth test, at a speed of 28 miles per hour, some of the blocking back of one of the buffers was smashed by the concussion, and one of the car trucks broke loose from its fastenings, and stripped the body bolster. This was due to the momentum of the heavy truck, and the sudden stoppage of the car body. On the fourteenth test, a speed of 30 miles per hour was reached, with the result that one center sill on the moving car was cracked near the body bolster, and both center sills of the fixed car were cracked at the same place; the drawhead of the fixed car was also broken in the shank; the bolsters under both cars were partially stripped from their positions. The buffers, however,



LEEDS' DRILLING MACHINE.

(*Patent applied for.*)

remained intact and uninjured. The two cars were so badly used up as to be unfit for further service, while the buffers will be transferred to other cars and continued in service.

As has been heretofore noted, this buffer is manufactured by the Union Switch & Signal Company; its essential feature is, that friction is developed between interlocking sets of thin plates, and is brought into play as an aid to the regular draft springs in receiving and absorbing the momentum due to shocks which occur so frequently in the ordinary process of shifting and making up freight trains, and which are of daily occurrence on the road when trains are stopped and started, or are running over undulating grades.

Locomotives.

THE Schenectady, N. Y., Locomotive Works, have taken a contract to build six heavy locomotives for the Cleveland, Columbus, Cincinnati & Indianapolis Railroad.

THE Strong Locomotive, *A. G. Darwin*, the trial of which on the New York, Providence & Boston Railroad was recently noted, is now running on the Susquehanna Division of the New York, Lake Erie & Western Railroad between Susquehanna and Hornellsville. This is a particularly difficult section of the road and will give the engine a severe test.

THE Manchester, N. H., Locomotive Works have recently delivered two Mogul freight engines to the Boston & Maine Company, for use on the Central Massachusetts Division.

THE work on hand at the Rhode Island Locomotive Works, in Providence, includes 25 passenger locomotives with 18 × 24-in. cylinders for the Union Pacific; 10 passenger engines with 18 × 24-in. cylinders, and five Mogul passenger engines with 19 × 24-in. cylinders for the Chicago, Burlington & Quincy Railroad, besides several smaller orders for other roads. These Works have recently added to their smith shop three steam hammers made by Bement, Miles & Company in Philadelphia.

THE Boynton "Bicycle" locomotive, for a single-rail railroad, which has been built by the Portland Company in Portland, Me., was tried recently in that Company's yard, and is soon to be put at work on a short road, built by its inventor, Mr. Moody Boynton.

THE shops of the Pennsylvania Company in Fort Wayne, Ind., are building 10 consolidation engines, with Belpaire fireboxes.

Cars.

THE Pullman Car Company is building in its shops at Pullman, Ill., 200 coal cars for the Colorado Midland Railroad.

THE Buffalo Car Manufacturing Company is building 150 box cars for the Delaware & Hudson Canal Company, and 200 for the Cleveland, Columbus, Cincinnati & Indianapolis Railroad. The Company is building an addition to its wood-working shop and a new paint shop.

THE United States Rolling Stock Company has begun the manufacture of passenger cars in its Chicago shops; the first order is for 27 cars for a Southern road.

THE Lehigh Car Manufacturing Company at Stemton, Pa., recently shipped a number of ore cars to the Juragua mines in Cuba.

THE Fox Solid Press Steel Company has been organized for the purpose of building the Fox steel truck, and is erecting shops at Joliet, Ill., near the Works of the Joliet Steel Company. The officers of the new Company are: A. J. Leith, President; H. S. Smith, Vice-President; W. R. Stirling, Superintendent, and E. W. Hughes, Chief Engineer.

THE Springfield Car & Foundry Company has been organized to build car shops at Springfield, Mo. The new company will build a car-wheel foundry and freight-car shops in that place at once.

THE car shops of the Pennsylvania Company in Fort Wayne, Ind., are running on an order for 200 box cars, 130 for the Pittsburgh, Cincinnati & St. Louis, and 70 for the Pittsburgh, Fort Wayne & Chicago Road. These cars are to be of 60,000 lbs. capacity and are to be equipped with Westinghouse air brakes and Janney couplers. The Graham draft-rigging will be used in connection with the Janney coupler.

Marine Engineering.

THE Baltimore, Chesapeake & Richmond Steamship Company has contracted with Neafie & Levy in Philadelphia for an iron passenger boat, to run on the Chesapeake Bay line between Baltimore and West Point. This boat will be 240 ft. long, 38

ft. beam, and 24 ft. depth of hold, and will have triple-expansion engines, with cylinders 21 in., 34 in., and 55 in. diameter and 36 in. stroke.

THE Standard Oil Company has contracted with the Columbian Iron Works, Baltimore, for a tank steamer to carry 500,000 gallons of oil. This steamer will be 240 ft. long, 36 ft. beam and 23½ ft. deep, and will have triple-expansion engines with cylinders 19 in., 30 in., and 50 in. diameter and 36 in. stroke.

THE William Cramp & Sons Ship & Engine Company, in Philadelphia, are building a new steamer for the Morgan Line, after the designs of Mr. George B. Mallory, of New York. This vessel will be 350 ft. long over all, 42½ ft. beam, and 36½ ft. deep, and will have a carrying capacity of 3,000 tons of freight. She will have triple-expansion engines with cylinders 29 in., 45 in., and 74 in. diameter and 54 in. stroke, and will have four boilers 14 ft. diameter and 22 ft. long, carrying a working pressure of 160 lbs.

THE Harlan & Hollingsworth Company, in Wilmington, Del., have contracted to build a large transfer boat for the New England Terminal Company, to run between Jersey City and the Harlem River station in place of the old *Maryland*, which was recently destroyed by fire. This boat will be a side-wheel steamer 280 ft. long, 44 ft. beam and 17 ft. depth of hold, and will be driven by two independent compound engines, one to each wheel. Work on this boat is to be hurried as much as possible.

Pig Iron Production in 1888.

(From the *Bulletin* of the American Iron and Steel Association.)

THE total production of pig iron in the United States in 1888 was 7,269,628 net tons, or 6,490,739 gross tons, against 7,187,-206 net tons, or 6,417,148 gross tons, in 1887. The production in 1888 was slightly in excess of that of 1887, and was the largest in our history. The extraordinary activity of the furnaces in the last few months of the year, notably in November and December, brought the total production far above the figures indicated by the statistical results of the first half of the year and by subsequent unofficial statements. While an increased production in the last half was anticipated, general surprise will be expressed upon learning how great it has been, which is shown as follows:

Production.	Gross tons.
First half of 1888	3,020,092
Second half of 1888	3,470,647

The total production of pig iron in this country since 1881 has been as follows, in gross tons:

Years.	Gross tons.	Years.	Gross tons.
1881	4,144,254	1885	4,044,526
1882	4,623,323	1886	5,683,329
1883	4,595,510	1887	6,417,148
1884	4,097,858	1888	6,490,739

Our production of pig iron in 1888, classified according to the fuel used, was as follows, compared with the production in 1885, 1886, and 1887:

Fuel—Net tons.	1885.	1886.	1887.	1888.
Bituminous	2,675,635	3,806,174	4,270,635	4,745,110
Anthracite	1,454,390	2,099,597	2,338,389	1,925,729
Charcoal	399,844	459,557	578,182	598,789

The anthracite figures include all pig iron made with mixed anthracite and coke, as well as that made with anthracite alone. The production of pig iron with anthracite alone is now annually less than that made with charcoal.

The production of pig iron in the Southern States in 1887 did not equal the general expectation, being only about 50,000 gross tons in excess of the production in 1886. But in 1888 the Southern pig-iron industry made a great stride forward. The production was as follows, compared with the production in 1885, 1886, and 1887:

States—Net tons.	1885.	1886.	1887.	1888.
Alabama	227,438	283,859	292,762	449,492
Tennessee	161,199	199,166	250,344	267,931
Virginia	163,782	156,250	175,715	197,396
West Virginia	69,007	98,618	82,311	95,259
Kentucky	37,553	54,844	41,907	56,790
Georgia	32,924	46,490	40,947	39,397
Maryland	17,299	30,502	37,427	17,606
Texas	1,843	3,250	4,383	6,587
North Carolina	1,790	2,200	3,640	2,400
Total	712,835	875,179	929,436	1,132,858

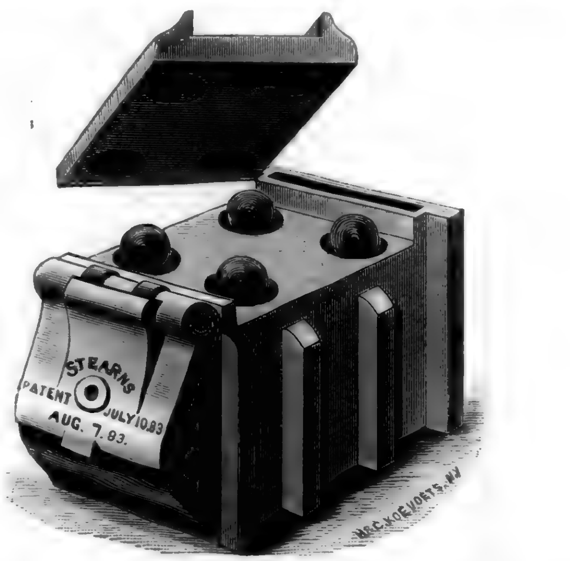
The increased production of pig iron in the Southern States in 1888 over 1887 was over 203,000 net tons. As late as 1865 the whole country made less pig iron than the South made in 1888.

Among the Northern and Western States which increased their production of pig iron in 1888 as compared with 1887 Pennsylvania is not to be counted; she made less in 1888 than in 1887. So did New York, New Jersey, Maryland, Wisconsin, and Missouri. Michigan's and Connecticut's figures for the two years do not materially vary. Illinois, Indiana, and Massachusetts show slight gains in 1888. Ohio shows a great gain, jumping from 975,539 net tons in 1887 to 1,103,818 net tons in 1888, and nearly equalling the production of the whole South.

Notwithstanding the large production of pig iron in the last few months of 1888, there was no increase of unsold stocks beyond the quantity on hand at the close of the first six months of the year; on the contrary, there was a decrease. The stocks of pig iron which were unsold in the hands of manufacturers or their agents at the close of 1888, *and which were not intended for the consumption of the manufacturers*, amounted to 336,161 net tons, against 401,266 net tons on June 30, 1888.

The Stearns Flexible Car-Axle Box.

THE accompanying illustration shows a car-axle box, manufactured and introduced by the American Railway Equipment Company of New York. The box is the same as the ordinary standard journal box, and in fact the device may be applied to any journal box of ordinary form. The arrangement consists of four steel balls, placed on top of the box and carrying a special cap upon which the equalizing lever of the truck rests. These steel balls are about 2 in. in diameter and are allowed to play in depressions about ½ in. deep in the top of the box, the cap



resting upon them having similar depressions. It is claimed that this device allows the journals to remain always in exact lines with their bearings, by providing for an oscillating movement between the box and the load and allowing a certain amount of radial movement on curves. Shocks are thus avoided and a very easy motion given to the car.

No change is required in the style of journal used, or in the interior of the box, and it can be used with any ordinary pedestal, so that it can be very easily applied to trucks now in use. This box is in use by the Wagner Palace Car Company and has been tried successfully on the New Jersey Central, the New York Central, the New York, Lake Erie & Western, the Delaware & Hudson Canal Company's lines, the Wabash Western, the Cincinnati, New Orleans & Texas Pacific, and other roads. The Wagner Company has a large number of its cars equipped with this box.

OBITUARY.

ALBERT M. SHAW, who died at his residence in Lebanon, N. H., January 31, was a well-known civil engineer for many years. He had been connected with the Boston & Providence, the Old Colony, and many other New England roads.

P. D. FISHER, who died in Indianapolis, Ind., January 28, had been connected as Assistant and Chief Engineer with the Columbus & Hocking Valley, the Kansas Pacific, the Toledo,

Delphos & Burlington, and many other Western roads. For some time past he had been Consulting Engineer of the Lake Erie & Western Railroad.

COLONEL FRANK S. PARROTT, who died in Bridgeport, Conn., January 29, aged 28 years, studied at Yale College, and some years ago became associated with his father and brother in the management of the extensive business of the Parrott Varnish Company. He was exceedingly popular, was active both socially and politically, and his death is regretted by many friends. He held a position on the staff of the Governor of Connecticut.

E. S. PHILBRICK died very suddenly while on his way from Boston to his home at Brookline, Mass., February 13. He was 65 years old and was widely known as a civil engineer of ability, having had charge of many important works, chiefly in New England. For some time past he had been Consulting Engineer of the Boston & Albany Railroad, and his services had been required as Consulting Engineer on railroad, bridge, and city works.

CORNELIUS H. DELAMATER, who died in New York, February 7, aged 67 years, was the founder of the great Delamater Iron Works in that City. He began work at 14 as clerk in a hardware store, and some years later was clerk in the old Phœnix Iron Works. In 1845 he undertook the management of those Works in partnership with Peter Hogg, and this firm continued until 1857, when Mr. Hogg retired, and the Works were afterward known under their present name. For a number of years Mr. Delamater was intimately associated with Captain John Ericsson, and many of his inventions were worked and constructed at the Delamater Works. During the war these Works did an immense amount of work for the Government, building the machinery of many war vessels; the original *Monitor* was also built and equipped there.

After the war Mr. Delamater retired from active work, but for a short time only. He resumed the management of the Works and continued actively engaged until his death. His son, who was associated with him for a number of years, will succeed him in charge.

SAMUEL MORSE FELTON, who died in Philadelphia, January 24, aged 79 years, was born in West Newbury, Mass., graduated from Harvard College in 1834, and studied civil engineering. He was employed in the construction of railroads for a time, became Superintendent and Engineer of the Fitchburg Railroad in 1843, and left it in 1851 to become the President of the Philadelphia, Wilmington & Baltimore Railroad Company, which position he occupied until 1865, when he resigned, owing to ill health. He was soon after chosen President of the Pennsylvania Steel Company, the first company in this country to make the manufacture of Bessemer steel rails a commercial success, and retained that position until his death. He was a Commissioner of the Hoosac Tunnel in 1862, and a Government Commissioner of the Union and Central Pacific railroads in 1869. He was a member of the Centennial Board of Finance, and a director of the Northern Pacific Railroad Company from 1870 to 1873, and of the Pennsylvania Railroad Company from 1873 to 1883. He leaves a widow, four daughters, and three sons.

Mr. Felton will be chiefly remembered for his successful management of the Philadelphia, Wilmington & Baltimore Railroad during the war, when such a strain was thrown upon the resources of that line as no railroad in this country had ever experienced before. Entirely new conditions had to be met, new problems solved, and new demands satisfied with very little time for decision. Mr. Felton was equal to the position, and in it did work quite as valuable to the Government as that of many generals in the field.

PERSONALS.

M. BECKER has been appointed City Engineer of Austin, Minn.

A. J. PORTER is now Superintendent of the Kentucky & Indiana Bridge at Louisville.

JOHN C. HASKELL has been appointed Superintendent of Water-Works at Lynn, Mass.

CAPTAIN F. M. RAMSEY, U.S.N., has been ordered to the command of the Brooklyn Navy Yard.

W. MCWOOD now has charge of the Car Department on all the lines of the Grand Trunk Railway.

JOHN BROOKS has resigned his position as Superintendent of the Water-Works at Lansingburgh, N. Y.

J. K. LAPE has been appointed General Master Mechanic of the St. Joseph, St. Louis & Santa Fé Railroad.

C. K. DOMVILLE will hereafter have charge of the Grand Trunk Railway Company's foundries at Hamilton, Ontario.

HERBERT WALLIS now has charge of the Locomotive and Car Departments on all the lines of the Grand Trunk Railroad.

E. P. HENDERSON is now Master Mechanic of the Fort Worth & Denver City Railroad, with office at Fort Worth, Tex.

JOB ABBOTT, President of the Dominion Bridge Company, of Montreal, has opened an office at No. 150 Broadway, New York.

JOHN A. COLEMAN, the well-known engineer of Providence, R. I., has been elected Commissioner of Public Works of that City.

HON. WALTER L. BRAGG, of Alabama, has been reappointed a member of the Interstate Commerce Commission, for a new term of six years.

F. W. COOLBAUGH has been appointed Secretary of the American Live Stock Express Company, with office at 45 Broadway, New York.

JOHN B. HEIM, for seven years past Superintendent of Water-Works at Madison, Wis., has resigned that position to go into private business.

JOSEPH O. OSGOOD has resigned his position as Chief Engineer of the Lake Shore & Michigan Southern Railroad, which he has held for about a year.

THOMAS DOWNING has resigned his position as Master Mechanic of the Eastern Division of the Atchison, Topeka & Santa Fé Railroad.

CHARLES H. JONES, JR., has resigned his position as Secretary of the South Baltimore Car Works, to become General Manager of the Suffolk & Carolina Railroad.

W. M. HUGHES, recently Bridge Engineer in the office of the City Engineer of Cleveland, O., has been appointed Assistant General Manager of the Keystone Bridge Company, at Pittsburgh.

CLEM. HACKNEY, who recently resigned from the Union Pacific, has been appointed Superintendent of Motive Power of the Missouri Railroad, taking the place of Mr. O. A. Haynes, who has resigned.

C. L. GOULD, for some years past Chief Engineer of the Cleveland & Marietta Railroad, has resigned that position and has gone to Chili to take charge of the construction of some new railroads in that country.

J. P. WILLIAMS, J. L. GIBBS, and GENERAL GEORGE L. BECKER are the members of the new Railroad and Warehouse Commission of Minnesota. Messrs. Becker and Gibbs were members of the old commission.

JOHN S. LENTZ, Master Car-Builder of the Lehigh Valley Railroad, will hereafter have the title of Superintendent of the Car Department. He will have entire charge of the cars in the car shops of the Company, reporting to the Second Vice-President.

WILLIAM VOSS, Assistant Master Mechanic of the Burlington, Cedar Rapids & Northern, and author of articles on Railway Car Construction in the *National Car-Builder*, has accepted the position of Assistant Engineer of the Fox Solid Pressed Steel Company, with headquarters in Chicago.

WILLIAM GLYDE WILKINS, late Assistant Engineer of Construction on the Pennsylvania Railroad, and W. BLEDDYN POWELL, late Architect for the same road, have formed a partnership under the name of Wilkins & Powell, at 20 McCance Block, Pittsburgh, and 3125 Powelton Avenue, Philadelphia. They will practice as engineers and architects.

JACOB TOME, for many years a director in the Philadelphia, Wilmington & Baltimore Railroad Company, has given $2,500,000 to establish and endow a manual training school in Port Deposit, Md., his native town. It will be for the benefit, first, of children of that town, and, secondarily, for those from all parts of Maryland.

WILLIAM H. BURR, formerly on the Mexican National, has been appointed Chief Engineer of a French Company, which has undertaken to construct several railroad lines in Venezuela,

and sailed for that country early in February. He took with him as his Chief Assistant CHARLES CORNER, late Resident Engineer of the San Antonio & Aransas Pass Railroad.

PROCEEDINGS OF SOCIETIES.

American Society of Mechanical Engineers.—The Secretary gives preliminary notice of the 19th Convention, which is to be held in Erie, Pa., in the latter part of May. The exact date will not be fixed until the sailing day of the steamers, which are to take the visiting party to England, has been settled.

Members desiring to present papers at this meeting are requested to send in manuscripts and drawings before March 16.

The Secretary announces that the European trip will certainly be successful, enough members having signified their intention to join to justify the Society in chartering the steamer, and it is possible that a second steamer may be necessary. Members desiring to join the party are requested to notify the Secretary as soon as possible.

American Society of Civil Engineers.—At the regular meeting in New York, February 6, the Secretary announced the deaths of the following members: H. D. Blunden, Nathaniel W. Ellis, and Louis Lesage, and of Samuel M. Felton, a fellow of the Society; and the election to fellowship of James J. Hill, President St. Paul, Minneapolis & Manitoba Railroad, St. Paul, Minn.

A paper on Cost of Horse Power on Street Railroads in New York and Brooklyn, by G. Leverich, was read. This was followed by a paper on Improvement of Channels in Sedimentary Rivers, by George H. Henshaw.

A long discussion arose on the question of balloting on a renewed application for membership. The question was finally referred to the Board of Directors.

The following elections were announced by the Tellers:

Members: Samuel Lispenard Cooper, Yonkers, N. Y.; Sören Theodor Munch Bull Kielland, Buffalo, N. Y.; Samuel Clarence Thompson, New York City; Frank Herbert Todd, St. Cloud, Minn.; Schuyler Skaats Wheeler (Junior, 1887), New York City.

Associate: James Frederick Lewis, New York City.

Juniors: James Benton French, Philadelphia, Pa.; George King McCormick, Johnson City, Tenn.

IN place of the regular meeting of February 20 a joint meeting with the American Institute of Mining Engineers was held, at which papers on Iron and Steel were presented and discussed.

New England Water-Works Association.—A special meeting was held in Boston, February 13. In the morning the members visited the Chadwick Lead Works, where they witnessed the manufacture of lead pipes and other products.

At the business session in the afternoon a paper was read on the Quincy Dam, by L. A. Taylor. This was followed by papers on Effects of Erosion on the Pacific Coast, by S. M. Allis; Experience with a Sand Blast, J. L. Harrington, with another paper on the same subject by Phineas Ball; Painting Stand-Pipes, by J. E. Beals; Placing the Walking-beam in the *Puritan*, by W. M. Hawes; An Experience with Water Meters, by H. J. Holden. The meeting was very largely attended.

Boston Society of Civil Engineers.—At the regular meeting of January 16, Arthur G. Fogg, Henry M. Howe, Walter H. Richards, and W. S. Whiting were elected members. A letter from the Engineers' Club of Kansas City with reference to transfers of membership between local societies was referred to the Governing Committee. A Committee was appointed to arrange for the annual dinner in March.

A paper, by George H. Barrus, on Duty Trials of Pumping Engines, was read, and a short discussion followed.

Engineers' Society of Western Pennsylvania.—The ninth annual meeting was held in Pittsburgh, January 22. The reports of the officers showed that the Society was in good condition and that the attendance of the meeting had been large; the financial condition was also good. The President read an address reviewing the work of the past and giving suggestions for the future.

The following officers were elected: President, John Brashear; Vice-President, A. E. Hunt, Jr.; Directors, William Metcalf and M. J. Becker; Secretary, Colonel S. M. Wickersham; Treasurer, A. E Frost. Five new members were also elected.

After the close of the meeting a collation was served and a social meeting held.

The Secretary desires to say that engineers from other parts of the country who are visiting Pittsburgh are cordially invited to attend the meetings, or to call at any time at the rooms of the Society in the Penn Building.

Western Society of Engineers.—At the annual meeting in Chicago, January 8, the Secretary submitted amendments to the by-laws equalizing the dues of resident and non-resident members.

The retiring President, Mr. Gottlieb, made a brief address in regard to the work of the Society during the past year, and Vice-President Weston also made an address. The Secretary presented his annual report, showing a total of 191 members. The receipts for the year, $1,467, and the balance on hand, $164. The report noted the work done by the Committees, the papers read, and other proceedings of the Society, and urged that steps be taken to provide permanent quarters.

The following elections of officers were announced: President, E. L. Corthell; Vice-Presidents, Charles McRitchie and Samuel McElroy; Secretary, John W. Weston; Treasurer, H. W. Parkhurst; Librarian, G. A. M. Liljencrantz; Trustee, Charles Fitz-Simons.

The proceedings were closed by the annual supper, at which speeches were made, and which was attended by about 40 members.

Engineers' Club of St. Louis.—A regular meeting was held in St. Louis, January 16. A letter was received from the Engineers' Club of Kansas City in relation to transfer of members; this was discussed and then laid over to the next meeting.

A paper on Wrought-Iron and Steel Eye-bars, by Carl Gayler, was read, describing manner of making and testing them. It was briefly discussed.

A paper on a Burr Truss, by Professor A. E. Phillips, was read, describing a bridge near Lafayette, Ind. This called out a long discussion, in which mention was made of several wooden bridges which had been standing for from 40 to 50 years.

A committee was appointed to present a memorial to the Missouri Legislature in favor of the proposed Act for the safety of bridges.

A REGULAR meeting was held in St. Louis, February 6. Edward E. Wall, Henry Groneman and Nils Johnson were chosen members, and a number of applications were received.

The special committee on Bridge Reform Legislation reported progress and the memorial to the State Legislature was read.

Professor J. B. Johnson read a paper on Cable Conduit Yokes, their strength and design, giving the results of a number of tests made on different forms of yokes, and submitting a design for a new form composed of cast iron, strengthened by a steel tension member. This paper called out a discussion in which several members gave accounts of their experience with cable roads in St. Louis and elsewhere.

The question of transfer of membership was brought, discussed, and finally referred to the Executive Committee. The question of closer organization among the different engineering clubs was brought up and discussed at considerable length, and finally a committee, consisting of S. B. Russel, J. A. Seddon, and J. B. Johnson, was appointed, to devise a plan for a closer union among the different clubs.

Minneapolis Society of Civil Engineers.—At the regular meeting in Minneapolis, February 6, the papers read were on Solar Attachments, by W. R. Hoag, and on Subdivision of the Section, by G. W. Sublette. Both were discussed by members present.

Michigan Engineering Society.—A meeting was held at Lansing, Mich., January 23. The first paper was on Brick Street Pavements, by Professor C. E. Greene, of Ann Arbor, which gave qualities desirable for paving brick and detailed results of experience in a number of Western, Southern, and Eastern cities. The conclusion was that brick was superior to many other materials for ordinary street traffic, providing a proper selection was made. This paper called out a good deal of discussion, general opinion seeming to be somewhat against brick and in favor of asphalt.

Two sessions were held. Other papers read were on a New Method for Longitude, by H. C. Reassons; on Building Stones, by Professor W. H. Pettee; on a Special Agent's Trip in Nevada and Nebraska, by Isaac Teller; and on Water-Supply of Kalamazoo, by William B. Coates.

Northwestern Society of Civil Engineers and Architects.—This Society has been organized in Portland, Ore., with 20 members. The officers are: President, Captain Cleveland Rockwell; Vice-President, William Stokes; Secretary, R. A. Habersham; Treasurer, J. Krumbein; Librarian, H. G. Gradon.

Engineers' Club of Kansas City.—A regular meeting was held January 21. Henry Goldmark and Gerald Bourke were elected members. The Committee on Bridge Reform reported progress.

A paper on Electric Railroads, by A. N. Connett, was read, describing several of those now in operation.

A paper on Shrinking of Material and Settlement of Embankments, by a member, was read, giving experience in actual construction.

THE annual dinner of the Club was held January 28; there were present 33 members and several guests. Speeches were made and the affair was thoroughly enjoyed by those present.

A REGULAR meeting was held February 4. Roland Norris, A. J. Tollock, R. H. Bacot, and A. R. Meyer were elected members. O. Chanute, George H. Nettleton, and Charles F. Moss were elected honorary members.

A paper on Details of Iron Highway Bridges was read by E. W. Stern, describing ordinary practice, and speaking especially of the Schwedler truss. This was discussed by members present.

Illinois Society of Engineers and Surveyors.—The fourth annual meeting was held at Bloomington, Ill., January 23, 24, and 25, when a large number of papers were read, including an address from the President, C. G. Elliott, on Drainage of Large Tracts of Farming Land. Among the papers read were: The Cairo Bridge, by S. E. Balcom; Brick Construction in Engineering, by Professor I. O. Baker; the Metric System, by S. S. Greeley; Experience with a Culvert, by E. A. Hill; Sewage Disposal, by Professor A. N. Talbot; Springfield Water-Supply, by S. A. Bullard; Sources of Water-Supply and Their Development, by D. W. Mead; Mining Plant, by A. C. Brancher; a New Mexico Coal Mine, by G. W. Richards; Methods of Measuring Earth Work, by E. L. Morse; Municipal Engineering, by A. H. Bell; another paper on the same subject, by John W. Alvord; Section Subdivisions, by Henry C. Niles; Laws Relating to Division of Sections, by Z. A. Enos; Exterior Boundary of Townships, by F. Hodgman; Levee Construction, by E. J. Chamberlain; Electric Lighting for Small Cities, by J. H. Garrett; Railroad Accidents, by S. F. Balcom; Specifications, by W. D. Clark; Pavements, by G. W. Wightman; a Park Topographical Survey, by E. I. Cantine.

There were also discussions on a number of subjects of interest, including Systems of Track-work, Pavements and other matters. A large exhibit of drawings was made at the meeting. During its continuance the members visited the Chicago & Alton Shops, the City Water-Works, and other points of interest in the neighborhood.

The officers chosen for the ensuing year: President, C. G. Elliott, Gilman; Secretary and Treasurer, A. N. Talbot, Champaign.

Railroad Commissioners' Conference.—The following circular from the Interstate Commerce Commission was issued under date of January 31, and addressed to the State Railroad Commissioners:

"The State Railroad Commissions, with gratifying unanimity, have heartily approved the suggestion for a general meeting, and many who desire to attend have indicated the first week in March as the most convenient time;

"You are therefore invited to participate in a general conference of Railroad Commissioners, to be held at the office of the Interstate Commerce Commission, No. 1317 F Street, in the city of Washington, at 11 o'clock A.M., on the 5th day of March, 1889.

"Among the subjects which may be properly considered are the following:

"*Railway Statistics*, with especial reference to the formulation of a uniform system of reporting;

"*Classification of Freight*, its simplification and unification;

"*Railway Legislation*, how to obtain harmony in;

"*Railway Construction*, should regulation be provided?

"And such other topics affecting State and Interstate Commerce as may be brought forward by members of the Conference, the above suggestions not being designed to exclude the consideration of any other subjects of common interest.

"An opportunity will also be afforded for consultation in respect to the heating and lighting of cars, automatic car-coupling, continuous train-brakes, and other matters now more particularly within the sphere of State authority.

"Brief papers are invited from members of the Conference upon any topic deemed of importance. Arrangements will be made for preserving a permanent record of the proceedings."

Master Car-Builders' Association.—The following circular has been issued by the Secretary, from his office, 45 Broadway, New York City.

"At the last Annual Meeting of the Association, Lake George, Saratoga Springs, and Niagara Falls were selected as the three places from which a Committee were instructed to select one for the place of holding the next Convention. The Committee found that it was impossible to make satisfactory arrangements for hotel accommodations at either Lake George or Niagara Falls; and as none of the hotels at Saratoga will open as early as the second Tuesday in June—the regular time for holding the Convention—the Executive Committee authorized the postponement of the date of meeting to the fourth Tuesday of that month, which will be the 25th. The Annual Convention for 1889 will, therefore, be held at Saratoga Springs, beginning on that date at 10 A.M.

"All who attend the meeting will be entertained at Congress Hall, at a charge of $3 per day. One hundred and fifty rooms —the numbers of which have been specified—on the first and second floors, will be reserved for the members of the Association. Those who wish to engage rooms before the meeting, or to secure extra accommodations, should write to H. S. Clement, Manager, Congress Hall, Saratoga Springs, N. Y."

Franklin Institute.—The following is the programme of lectures to be delivered before the Institute during the month of March:

March 4: Unwholesome Trades and Occupations, Dr. H. A. Slocum.

March 11: Cable Telegraphy, Patrick B. Delany.

March 18: The Industries of Pennsylvania, Andrew Carnegie.

Association of North American Railroad Superintendents.—It will be remembered that at the last meeting of this Association the Committee on Roadway was authorized to offer a prize of $50 for the best essay on Track Work, the proper care of roadway and the most approved methods of building the superstructure of a railroad, accompanied by such estimates of cost as can be drawn by actual experience; also systematic track inspection and the plan of giving premiums.

Papers to be offered in competition for this prize should be sent to C. A. Hammond, Secretary, at 350 Atlantic Avenue, Boston, not later than April 10, 1889. Each paper should be signed with a motto or an assumed name, with directions for remailing to some railroad officer, giving correct address, to which manuscripts will be returned. The paper securing the prize will be retained for publication, and the writer's true name will then be obtained by the Committee.

Railroad Superintendents' Association of Memphis.—This Association has chosen the following officers for the ensuing year: President, J. H. Sullivan, Kansas City, Memphis & Birmingham; Vice-President, O. M. Dunn, Louisville & Nashville; Secretary, A. Gordon Jones, Little Rock & Memphis.

Central Railroad Club.—A meeting was held in Buffalo, N. Y., January 23. A number of members of the New England, New York and Western Club were present, by special invitation. A number of new members of the Club were elected.

The annual election resulted in the choice of the following officers: President, E. Chamberlain; Vice-President, A. C. Robson; Secretary and Treasurer, F. B. Griffith; Executive Committee, T. A. Bissell, E. Chamberlain, James Macbeth, Peter Smith, F. D. Adams, James R. Petrie, and Richard Donaby. President Chamberlain made a brief address.

A general discussion then followed on the Rules of Interchange, with special reference to the defects which would stop a car, and to Oil-boxes and Lids. Incidentally a good deal was said about Uniformity in parts of cars. Some suggestions for amendments to the rules were made.

After the meeting those present visited the Car-Wheel Works at East Buffalo and witnessed an exhibition of the Gould coupler in the East Buffalo yards. The meeting was closed by a dinner at the Tifft House.

New York Railroad Club.—At the regular meeting in New York, February 21, the subject was Heating and Lighting Passenger Cars. The meeting was opened by a paper on Steam Car Heating, showing the development and progress made, by E. E. Gold; this was followed by papers relating to different systems of heating.

A paper on Lighting Cars by Electricity was read by Dr. H. R. Waite. An exhibition was made on electric lighting, also an exhibition of the Pinch system of gas lighting.

Western Railway Club.—At the regular meeting, February 19, the subjects for discussion were:

Standard Axle for 60,000 lb. Cars; to be opened by a paper by Mr. Godfrey W. Rhodes.

Tender Trucks; to be opened by a paper by Mr. John Hickey.

Northwest Railroad Club.—At the regular meeting in St. Paul, February 5, the subject for the evening was Snow Plows and Flangers, continued from the preceding meeting.

Mr. W. T. Reed read a paper describing different kinds of flangers, and giving his experience with them, and recommending certain conditions to be complied with. Mr. M. Ellis and Mr. A. F. Priest also read papers giving their experience, and describing different devices in use. Mr. Ellis estimated the cost of running a flanger at $25 per 100 miles. The discussion was continued by Messrs. Ward, Lewis, Pattee, Barber, and others.

NOTES AND NEWS.

The Old Ironsides.—A miniature model of the *Old Ironsides*, the first locomotive built by Matthias W. Baldwin, in 1832, and the first locomotive to haul a train in the State of Pennsylvania, has been received by Mr. J. E. Watkins, Curator of Transportation and Engineering, from the Baldwin Locomotive Works, for the National Museum attached to the Smithsonian Institute. The workmanship, both internal and external, is a perfect reproduction of the original. The inscription states that as early as 1832 this locomotive attained a speed of 60 miles an hour.

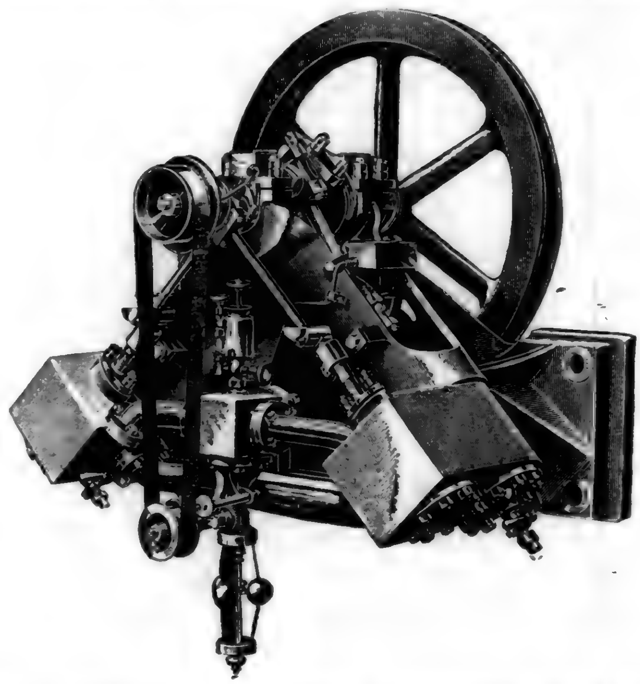
Italian Hospital Train.—A new hospital train has recently been built in Italy, which consists of six cars. Of these two are occupied by the surgeons, with their instruments and medicines; one by the kitchen and its attendants; one is used for provisions; one-half of the fifth is devoted to the "hospital administration," leaving only one-half of this car and the whole of the sixth for the accommodation of the wounded. The *Revue Scientifique*, in describing this train, makes this comment: "If this train is really intended for the service of the wounded, we must be permitted to find some disproportion between the space allotted to them and that taken up by the administrative service and the medical *personnel*."

Algerian Railroads.—In the French Colony of Algiers railroad building has been active for some time. An important line from Bougiah to Beni-Mansour was recently opened for traffic, and another main line from Blidah to Medeah is nearly completed. At the close of 1888 there were in operation 2,420 kilometers of railroad in the colony, owned by six companies, as follows: The East Algerian, 786; the Paris, Lyons & Mediterranean Company, 513; the Franco-Algerian, 434; the Bone-Guelma, 428; the West Algerian, 226, and the Mokta, 33 kilometers. The lines now under construction will bring this up to nearly 3,000 kilometers, or about one-tenth as much as the entire French mileage.

The Reading Elevated Line.—The amended plans for the new entrance into Philadelphia for the Philadelphia & Reading Railroad provides for the extension of the tracks from Ninth and Green streets to Twelfth and Market streets by an elevated structure, the entire removal of the tracks on Willow and Noble streets from Front Street to the west side of Broad Street, and on Ninth Street from Willow to Green, and the construction of elevated roads from Green Street to Glenwood Avenue on the Ninth Street Line, and from Front Street to Thirtieth on Willow and Noble streets and Pennsylvania Avenue.

The elevated structures on Willow and Noble streets from Front Street to Broad, are to contain two tracks, but those on Pennsylvania Avenue and from Market Street to Glenwood Avenue are to have four tracks. The lines will be of solid masonry from Twelfth and Market streets to Ninth and Green, and from Huntingdon Street to Glenwood Avenue, and from Twenty-sixth Street to Poplar on the Pennsylvania Avenue branch. The remaining portions will be built on iron columns of handsome design. The bridges which cross the streets are to be ornamental structures, and the best modern appliances are to be used for deadening the sound of trains.

An English Wall Engine.—The accompanying illustration (from *Industries*) shows a small compact engine built to run a 25-ton overhead traveling crane at the electric light station, Deptford, England, by W. H. Allen & Company, of Lambeth. This engine, which may be called a diagonal wall engine, is intended to drive the cotton rope of the overhead traveler, and will itself be fixed against the wall overhead. The steam valve will be controlled by a lever, from which hang two ropes, so that the engine may be started and stopped from the ground level. The arrangement of cylinders being diagonal, the engine has no dead points, and can be started from any position.



The cylinders are 5 in. diameter by 5-in. stroke, and the distribution of steam is by means of piston valves. The engine has been designed for a boiler pressure of 120 lbs., and is governed by a Pickering governor to a speed of 250 revolutions per minute. The whole design is exceedingly neat, and the oiling arrangements are such as to insure perfect lubrication with a minimum of attendance.

A New Coast Channel.—Work has been begun on a new canal or channel which is to extend from Delaware Bay through Delaware, Maryland and Virginia, parallel with the coast, to Chincoteague Bay, a distance of about 75 miles. This channel is to have a width of 70 ft. and a depth of 6 ft. at low water. Very little actual excavation will be required, most of the work being dredging through the bays or sounds along the coast, and in streams and creeks connecting them.

The route is from Lewes, Del., up Lewes Creek, and by the series of ponds near the head of that stream to Rehoboth Bay. Thence it passes through Indian River, Little Assawoman Bay, Big Assawoman Bay, and Sinepuxent Bay into Chincoteague Bay, down which the channel will be continued to the inlet below Assateague Island. The work will be done by the United States, the State of Delaware giving the right-of-way where necessary.

The German Navy.—It may be said that previous to 1850 Germany had scarcely any naval force, and the present navy has sprung into existence since that time. Much of the efficiency of the navy is due to the thoroughness of the training of the seamen and the high attainments of the *personnel* of the service. The last annual report of the German Navy showed that there were on the active list 7 admirals, 719 officers of all grades, including engineers and surgeons, and nearly 15,000 men.

In the list of vessels are 13 iron-clad ships and 14 iron clad cruisers. In the class of unprotected vessels are 9 cruisers, 10 corvettes, and 5 light cruisers. In all there are 98 vessels, carrying 554 guns, and having a sum total of 182,618 tons displacement. There are at present 76 completed torpedo boats of the first class and 18 in course of construction, some of which are very small craft and suitable only for harbor use.

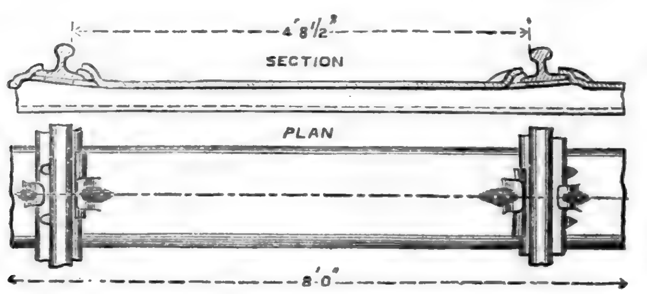
The most powerful vessel ever built for the German Navy was turned out from the Thames Iron Works, Blackwall, and called the *König Wilhelm*. In point of armor and heavy guns this vessel certainly has claim to the head of the German Navy List, but as to fighting qualities the opinions of foreign naval officers are on the whole adverse to the *König Wilhelm*. She is as clumsy as she is large, and though she is propelled by 8,300 H.P. and is a floating citadel in herself, the chances of a lighter and more manageable vessel against her are undoubtedly more favorable than one of her own kind.

Next to the *König Wilhelm*, in point of size and armament, are the sister battle ships *Deutschland* and *Kaiser*. Both of these vessels were constructed at Poplar, and were intended, in conjunction with the *König Wilhelm*, to form the nucleus of the iron-clad squadron of Germany. Sir Edward J. Reed was the designer of these vessels, and they are quicker and more easily manœuvered.

The most serviceable vessels that the Germans can count on are the four cruisers *Tieten*, *Blitz*, *Pfeil*, and *Hohenzollern*. These vessels are unprotected, though designed for offensive warfare. However, it may be stated that not a few foreign officers point to these four vessels as among the most efficient of modern cruisers.

The most recent addition to the navy is the *Greif*, a torpedo-chaser which is said to be the fastest war-vessel afloat.

An English Steel Tie.—In the improved steel sleeper of Messrs. Cabry & Kinch the jaws and studs are formed by hydraulic pressure entirely out of its own substance, as will be seen from the accompanying illustration. The tilt of the rail is obtained by pressing up, to the requisite angle, that portion of the sleeper only which is immediately under the base of the rail, instead of by the objectionable practice of bending the whole sleeper upward from the center. This enables the sleeper to be laid horizontally, and prevents its moving transversely in the ballast, thus obviating the necessity for closing the ends. The rail is placed in position by slightly tilting it, and passing one side of the flange under the inner or longer jaw, sufficient space being allowed for the outside of the flange to clear the shorter jaw, and then by sliding it under the shorter jaw, when the wedge-shaped steel split key is inserted under the longer jaw, and firmly driven. It will thus be seen that the flange is overlapped by both jaws of the sleeper, and that the rail cannot be forced out of them by the side pressure of the wheels of a passing train, even should the keys be displaced. The studs, against which the outside of the flange of the rail abuts, insure the permanency of the gauge of the railway, and



relieve the jaws of tearing strains. The cost at which this type of sleeper can be produced compares favorably with that of the ordinary chair and wood sleeper road, while its durability should be much greater, and a considerable saving in maintenance also be effected by its use. A considerable number of these sleepers has been laid down on the Central Division of the Northeastern Railway in the vicinity of Middlesborough, and they are also being laid upon the main line in the Northern and Southern divisions where the traffic is heaviest. The sleepers are made by Messrs. Bolckow, Vaughan & Company, Sheffield.—*The London Engineer.*

The Barranquilla Railroad.—The line of the Barranquilla Railroad & Pier Company in Colombia, South America, was formally opened for business on December 31 last. This line is short, but is commercially of great importance; it extends from Salgar to Puerto Colombia, giving the town of Barranquilla connection with deep water, and avoiding the tedious transfers and lighterage heretofore required to unload vessels.

The railroad from Salgar station to Puerto Colombia is 3½ miles long; the pier at the latter place is 861 ft. long, having for 200 ft. at its outer end a width of 33 ft., with double tracks, a storehouse 170 ft. long, and unloading cranes. At the end of the pier there is 14 ft. of water at low tide, and the pier is 8 ft. above high-water level.

The company is now building two additional warehouses, each 130 × 30 ft. The equipment at present consists of a locomotive and 43 cars, and will soon be increased.

The work has been done under the supervision and according to the plans of Mr. F. J. Cisneros, an engineer well known in this country. Mr. Llewellyn Lloyd was Chief Engineer in immediate charge of construction.

The Rose Polytechnic Institute.—This Institute, at Terre Haute, Ind., is a school especially devoted to the education of civil, mechanical, and electrical engineers. It owes its existence to the generosity of the late Chauncey Rose, of Terre Haute, who bequeathed something more than $500,000 for its establishment and support. It is one of the youngest of the technological schools of the country, having been opened in the year 1883.

One of the peculiar features of the Institute is the thorough and extensive shop practice of the students in mechanical engineering. Not only are machines designed and working drawings made, but actual construction is required and is made possible in extensive workshops, the equipment of which has cost over $40,000, care having been taken to make it as complete as possible.

In electricity, in addition to the instruments and appliances usually found in electrical laboratories, it possesses the most complete and accurately adjusted series of Sir William Thomson's electrical balances in this country, and there is a completely equipped testing room for the purpose of calibrating and standardizing commercial instruments.

Another important feature is the restriction placed upon the number of students admitted. The plan of the Institute is to limit the attendance to such an extent as to realize the great benefits arising from small classes.

Shipbuilding in Scotland.—On the Clyde last year we find that the total number of vessels launched was 302, aggregating 278,970 tons, steamers making up 227,783 tons, and sailing ships 51,187 tons. In 1887 the total production was 326 vessels, aggregating 185,362 tons, including 203 steamers of 147,537 tons, and 123 sailing ships of 37,525 tons. When compared with 1886 and 1885, last year's total is found to show an increase of about 100,000 tons; but 1884 had a larger total to its credit by nearly 18,000 tons. In 1882 and 1883, however, the production was abnormally high, being 391,934 tons and 419,664 tons respectively. If the average for the last fifteen years is placed alongside the total for the year just closed, it will be found that the comparison is not unfavorable to the past twelve months, the average being 246,044 tons, and the aggregate for 1888 278,970 tons.

In the Forth the same briskness has characterized the year's work, as fifteen vessels aggregating 12,211 tons were launched, while in 1887 the tonnage was 5,897 tons, and in 1886, 7,967 tons.

The production on the Tay is not so great as it was in 1887, only eight vessels of 11,197 tons having been built at Dundee, while in the previous year fifteen vessels of 14,245 tons were built; but in the two years preceding that the figure was very much less. The work on hand, however, is very much greater, making up a total of eleven vessels of 16,079 tons. Not since 1882 has there been so good a prospect.

At Aberdeen there has been a marked improvement in the trade during the year, nine vessels of 6,640 tons having been constructed, as compared with six vessels of 1,822 tons in 1887, and there are now in course of building nine vessels of 9,110 tons, whereas at the beginning of last year there were only four vessels of 5,114 tons on the stocks.—*London Engineering.*

A Japanese Canal.—The Japanese Government has now under construction a canal, the principal object of which is to carry the water of Lake Biwa to the city of Kioto, to be used there for domestic purposes. The main canal, however, has been made of sufficient size to be used by boats, which will carry freight from the towns on the shore of the lake to Kioto. The main canal, which is about six miles long, leaves the lake at Otsu, and ends at a point on high ground adjoining the city and at a level of about 138 ft. above the plain upon which the town is built. It has a depth of 6 ft., and varies in width from 19 ft. to 28 ft. The entrance from the lake is through a lock, which was rendered necessary by the variation of the level of the water in the lake, which is as much as 10 ft. between a dry and a wet season. There are five tunnels on the main canal, the longest being about 8,000 ft. from end to end; the others are generally short. The section of these tunnels is 16 by 14

ft.; wherever necessary they are arched with brick. There is one short aqueduct on the canal, constructed of brick arches. From a point near the terminus of the main canal at Kioto a branch canal diverges and is carried down by a circuitous route to a junction with the old canal already existing in the city, which runs through its whole length and then connects with the Kamo-Gawa River. This branch canal is not intended to receive boats, but is merely a conduit for carrying water, and is only 8 ft. wide by 4½ ft. deep. The length of this branch canal is 4¼ miles, and there are on it two short tunnels, which are circular in form, 6 ft. in diameter. The total cost of this work, which is nearly completed, is $1,250,000, which appears low to us; but account must be taken of the extremely low price of labor in Japan. The work has been designed by a Japanese engineer, Mr. Yanabe, and is being executed under his direction.

New English Steamships.—The shipyards of Harland & Wolff, at Belfast, recently launched the first of two new steamers which they are building for the White Star Line, and which are named the *Teutonic* and the *Majestic*. These steamers will be the longest vessels afloat, and are built expressly for speed, being intended for passenger boats. Their dimensions are: Length, 582 ft.; beam, 57½ ft.; depth, 39½ ft.; gross tonnage, 10,000 tons. They are built of Siemens-Martin steel, and will each be propelled by two independent sets of triple-expansion engines, driving twin screws, with blades of manganese bronze. Their passenger capacity will be 300 first-class, 150 second-class, and 750 steerage passengers, and it is promised that the accommodations will be better than those on any steamers heretofore built. One feature of these vessels will be the hurricane deck, which will have a length of 245 ft., with a clear width of 18 ft. on each side of the deck-houses.

The Fairfield Shipbuilding Company at Govan, Scotland, recently launched a new steamer named the *München*, for the North German Lloyds. This ship is of steel throughout, is 405 ft. long, 46½ ft. beam, and 33 ft. deep. She will be driven by one set of triple-expansion engines, having cylinders 30 in., 50 in., and 80 in. diameter, with 54-in. stroke. Steam is supplied by two double-ended boilers 14½ ft. in diameter and 17½ ft. long, with 12 corrugated furnaces. The ship is provided with a complete electric plant, and incandescent lights are placed in every part of the vessel. A sister ship, named the *Dresden*, which was recently built at the same yard, although not designed as a high-speed ship, made 14 knots an hour on her trial trip, the engines developing 3,000 H.P. These ships will each carry 40 first-class, 20 second-class, and 2,000 steerage passengers.

Mining in China.—United States Consul Denby, of Pekin, China, reports that the silver mines, situated in the Jeho district, a distance of about 45 miles to the northwestward of Ping-Chuan-Chow, are worthy of being tested carefully. An examination made by John A. Church, a distinguished American mining engineer, shows that a yield of 20 taels per ton may be expected.

In November, 1887, Mr. Church arrived at the Ku-Shan-Tzu mines and commenced work there. He reports favorably of this mine and thinks that it will pay, and is satisfied that the yield will be from 20 to 30 tons a day. The formation in which the mines are situated is a hard grayish-white limestone, which is bounded on the south and east by granite.

The valley which is the approach to the mines contains a stream of water, which is utilized by the miners in the washing of galena from the waste, which was mined and thrown to one side in former years. In getting to the ore Mr. Church found about 200 ft. of water in the old shaft, but after a month's steady work he succeeded in reaching the bottom of the shaft, which was 320 ft. deep, and found a vein 5 ft. thick. Samples were carefully selected from the average ore and showed that a small vein about 2 in. thick yielded 90 ounces per ton. Copies of assays made by Professor Church show as high as 420 ounces of silver per 2,000 lbs. of ore, the average for 20 specimens from the Ku-Shan-Tzu ores being 231.5 ounces; the poorest specimen showing 102 ounces.

Chinese methods of mining, as might have been expected, are very crude, but when the American system of mining is introduced it will have an immense effect upon the development of the mining industry. Chinese officials are lending Mr. Church every assistance, and his operations are being conducted under the immediate auspices of the powerful Li Hung Chang, Viceroy of Chi-Li.

English Locomotive Cranes.—The accompanying illustrations (from *Iron*) show two cranes built by the firm of Appleby & Company, East Greenwich, England. These cranes show types which are in very common use in that country, but are little known on this side of the ocean. They are exceedingly useful for many purposes, and might be used in many places here to advantage.

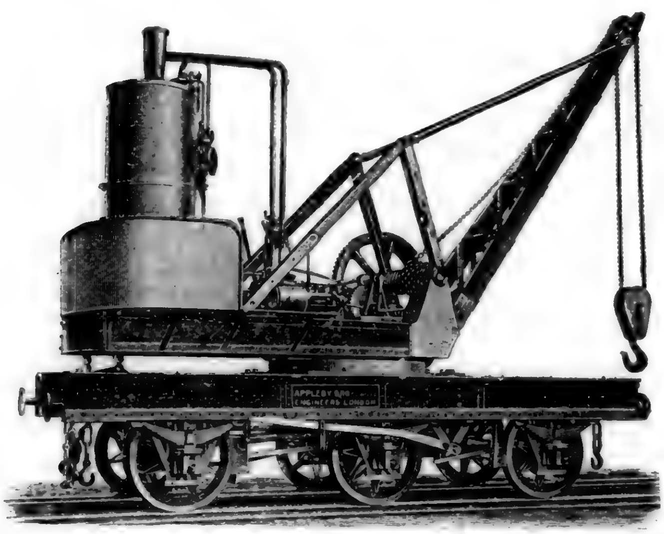


Fig. 1.

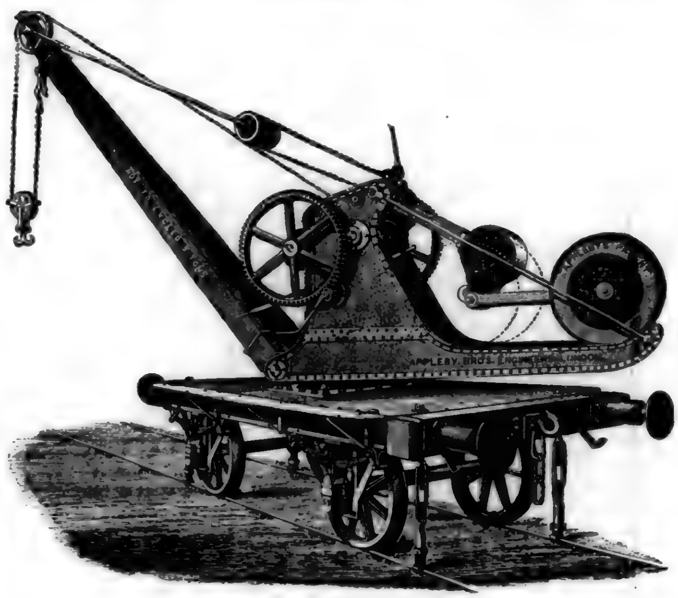


Fig. 2.

Fig. 1 shows the general design adopted by the heavier patterns of portable and locomotive steam cranes. These cranes are mounted upon a heavy wrought-iron frame, with wheels, springs, and axle-boxes, and are suitable for running on permanent way, and are fitted in all respects like the rolling-stock with which they are intended to work. The engraving shows a fixed jib, but they are sometimes fitted with an improved chain-and-lever derricking gear by which the jib is held and moved with the least possible strain on the framing.

Another type of cranes is that shown in fig. 2, which represents a portable hand-crane suitable for railroad permanent-way work, and fitted with a self-acting balance. In this arrangement the tie-rods, instead of making direct attachment to the side frames, have fitted to their lower ends chain sheaves, each carrying a chain. One end of each chain is attached to a chain barrel fitted with worm and wheel gear, while the other ends are coupled to the short arms of two bell-crank levers having a fulcrum on the top of the side frames. The lower ends of the long limbs of the bell-crank levers are fitted with weights, connected by wrought-iron links to the axis of a cylindrical balance-weight, which is free to roll on the tail-piece of the crane framing. When the load is being lifted, the strain due to the weight of the load passes through the tie-bars and chain to the short arms of the bell-crank levers, and the strain thus applied causes the long arms and weights to rise out of the vertical position and to move the cylindrical weights into the position shown, or until they are at a distance from the center sufficient to counterbalance the load being lifted. When the load is released, the levers assume the position shown by the dotted lines.

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NEW YORK, APRIL, 1889.

LAST winter was one of the mildest and most favorable to railroading known for many years. March has passed over without any repetition of the blizzard of last year, which is fortunate, because there is no indication that the railroads have profited by the lesson of the big storm. Even the Elevated roads, so far as we are aware, have not provided the little machinery necessary to prevent a repetition of the needless and annoying stoppage of trains, which caused so much of the trouble last year.

THE only bid received for the engines of the armored cruiser *Maine* is that of Messrs. N. F. Palmer, Jr. & Company, of the Quintard Iron Works, New York, whose price is $735,000. More bids wers expected by the Department, but none were received. The *Maine* is to have two vertical triple-expansion engines, with cylinders 35½ in., 57 in., and 88 in. in diameter and 36 in. stroke, each set of engines working a separate screw and each placed in a separate compartment; these engines are expected to develop 9,000 H.-P. when working under forced draft. They will be, if the specifications of the Navy Department are complied with, the finest engines of their class ever built in this country. The specifications for the engines of the battle ship *Texas* have been prepared and distributed.

THE French Syndicate, which undertook some time ago to corner the copper market and to regulate the prices of the world's supply of this metal, seems to have finally failed, the burden of carrying the enormous amount of metal, which had accumulated on its hands having proved too great for the means at the command of the Syndicate. For some time it seemed as if it would be successful, and the price of copper in London was carried up from about $200 to $425 per ton for Chili bars. In order to maintain this price, however, it was necessary not only to make arrangements with the chief copper mines all over the world, but also to shut off the great increase of production which might be expected from the smaller and less profitable mines, which desired to seize the opportunity offered by this great increase in price. Negotiations to limit production seem to have failed, while the high price of the metal decreased consumption, and the constantly growing stock on hand proved too much for the Syndicate. Rumors affecting its strength have been frequent of late; these were finally confirmed, and on March 18 the price of copper broke in London, and Chili bars, which had been quoted a few days before at $400, were sold at $175 per ton, the lowest price on record.

The failure of the Syndicate will be disastrous to its members and backers, but manufacturers and the public generally will have but little sympathy for them, and the great copper Syndicate—if, as seems to be the case, it is really dead or fatally crippled—will be finally buried with very few mourners.

JOHN ERICSSON.

CAPTAIN JOHN ERICSSON, Engineer, late of his Swedish Majesty's Service, and since 1839 resident in the United States, died on Friday, March 8, at his house in Beach Street, in New York City. All who were acquainted with the work of this remarkable man on hearing the announcement of his death must have felt that one of the great men of the age had passed away. With the remarkable development of science and engineering and the growth of the modern means of transportation, it is hard to realize that a person whose life has just ended was a participant in that early and remarkable trial of locomotives on the Liverpool & Manchester Railroad in 1829, which may be regarded as the beginning of the railroad development of the past half century. This development has been so rapid that a single life has covered the period, from its infancy to the present time.

Captain Ericsson was born in Wermland, in Sweden, July 21, 1803, so that he was in his 86th year at the time of his death. His father was a proprietor of mines and his mother was the daughter of an iron-master. In early life John Ericsson developed a taste and genius for mechanical pursuits, and at the age of twelve he was made a cadet of mechanical engineers, and the following year a leveller on the canal. At seventeen Ericsson entered the army as ensign, and rapidly reached a lieutenancy, in consequence of his beautiful military maps, which had attracted the special attention of King Charles John (Bernadotte).

At this early period of his life he had acquired a mastery of the language, or means of representing his ideas graphically. But mechanical drawing is not only a vehicle for expressing thoughts, it is an important instrumentality to aid and systematize thought, just as algebraic symbols and formulæ assist the mathematician. Ericsson was said to be a master of graphical means of developing his ideas. He spent much of his time over a drawing-board, and took great pains to have his ideas completely and even artistically elucidated by drawings, some of which were matchless examples of the draftsman's art.

His wonderful career as an engineer was in great part due to his remarkable capacity for thus expressing his ideas in tangible form. Mechanical drawing bore the same relation to his career that language does to that of an orator or statesman. Many men think great and wise thoughts, but cannot express them; others have the gift of words, but nothing else. It is also true that few of us know how incomplete and incoherent much of our thinking

is until we put it into language. It is equally true of inventors and engineers that they never know how imperfect and undeveloped their crude ideas are until they represent them on paper, and their capacity, or rather incapacity, for working them out often puts a limit to their usefulness. It is true that many men are good draftsmen who never become great engineers or inventors, but it is perhaps equally true that without the capacity to represent his ideas definitely and clearly, a person can never reach the highest rank as an engineer or inventor.

Ericsson was a man of surpassing originality and of boundless mechanical resources and expedients, with the logical faculty of drawing deductions from the data and phenomena presented to him, and, moreover, he had the ability, which is perhaps rare with such men, of being able to express and work out graphically his deductions and conceptions into tangible form. To sum up the whole matter in other words, he was a good draftsman.

In 1826 he went to London, on leave of absence, to introduce what is called a "flame engine." No description of this invention is within reach as this account of his life is being written, but probably it was some form of what afterward was developed into the famous caloric engine. Once in England, he resigned his commission in the Swedish Army. His resignation was accepted, but he was first promoted to a captaincy. He never returned to his native country, but received many honors from his countrymen. In an account of his life which originally appeared in *Scribner's* (now the *Century*) *Magazine*, it is said :

> The records of the London Patent Office show how rapidly his inventions succeeded each other, and a list of his engineering works during the thirteen years he spent in England bears testimony to his achievements. Among these works were a pumping engine on a new principle ; engines with surface condensers and no smoke stack, blowers supplying the draft, applied to the steamship *Victory* in 1828 ; and an engine consisting of a hollow drum which was rotated by the admission of steam, and continued to rotate for some hours after shutting off the steam, at the rate of 900 ft. per second at the circumference, or the speed of London moving around the axis of the globe. Apparatus for making salt from brine ; mechanism for propelling boats on canals ; a variety of motors actuated by steam or hot air ; a hydrostatic weighing machine to which the Society of Arts awarded a prize ; an instrument now in extensive use for taking soundings independently of the length of the lead line ; a file-cutting machine, and various others, are included in this list to the extent of some fourteen patented inventions and forty machines, all novel in design.

In 1829, when the Liverpool & Manchester Railway Company offered a prize of £500 for the best locomotive-engine for their road, Ericsson entered to compete for it. The conditions were that the engine must burn its own smoke, and if it weighs six tons must draw a train, including the tender and water, weighing 20 tons, at a rate of 10 miles per hour, with a pressure of steam of 50 lbs. per square inch.

The locomotives which appeared on the ground were :

1. *The Novelty*, by Messrs. Braithwaite & Ericsson, of London, weight, 2 tons 15 cwt.

2. *The Sans Pareil*, by Mr. Hackworth, of Darlington, weight, 4 tons 8 cwt. 2 qrs.

3. *The Rocket*, by Mr. Robert Stephenson, of Newcastle-upon-Tyne, weight, 4 tons 3 cwt.

4. *The Cycloped*, by Mr. Brandreth, of Liverpool, weight, 3 tons, worked by a horse.

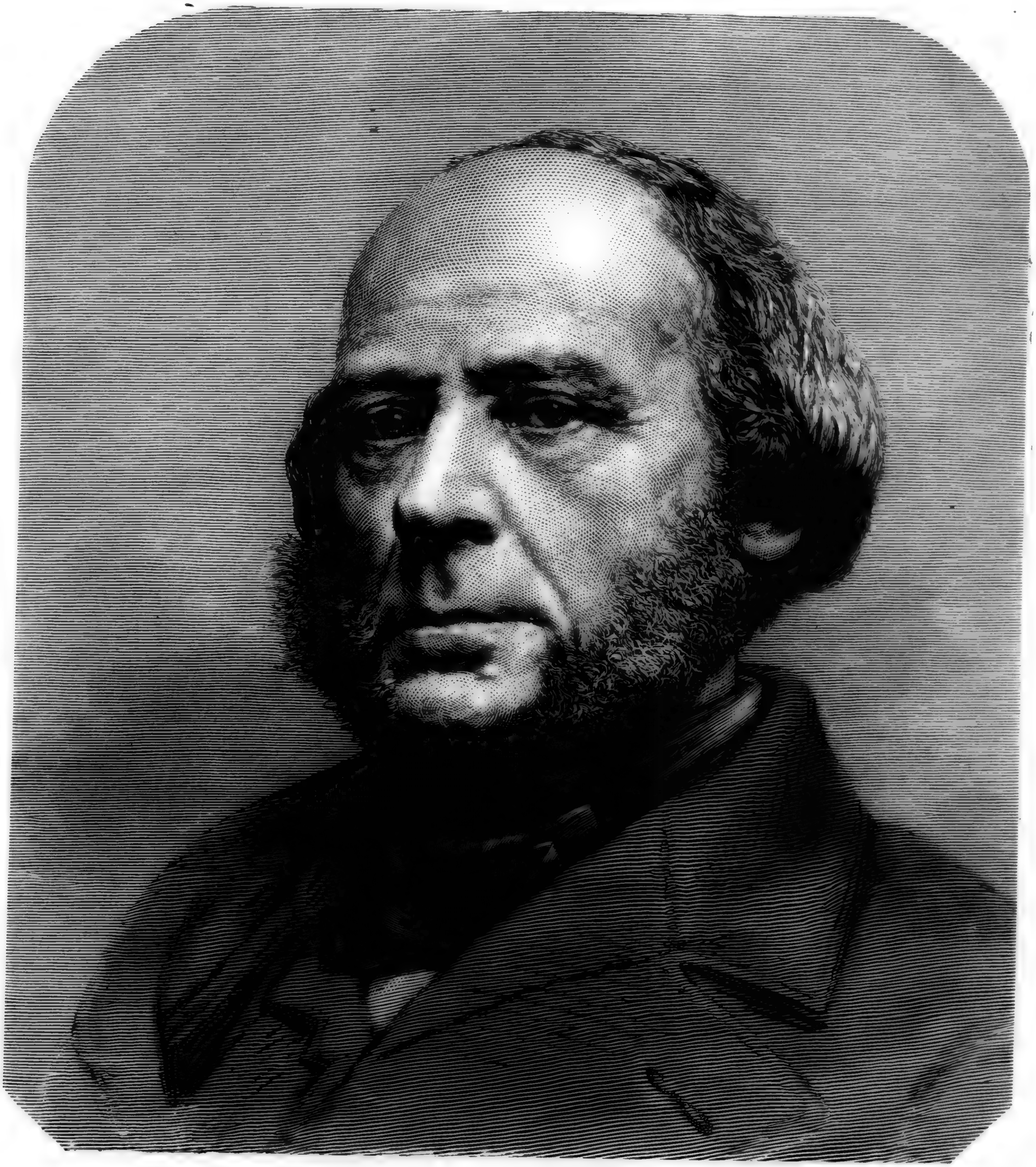
The drawing for the engraving of the *Novelty*, given on another page, was furnished some years ago to the *American Artisan* by Mr. Ericsson himself, and is, therefore, authentic. It was published in that paper and in the *Railroad Gazette* in 1875.

Accounts of this celebrated trial have been published very often and, as is well known, the prize was awarded to Stephenson's *Rocket*. The London *Times*, of October 8, 1829, said that the *Rocket*, without a train,

> Ran at the rate of 24 miles in the hour, shooting past the spectators with amazing velocity. . . . Cars weighing, with its own weight, upward of 17 tons were then attached to it, and the trial proved that the carriage (locomotive) can, drawing three times its own weight, run at the rate of more than 10 miles an hour. . . .
>
> But the speed of all the other locomotive steam-carriages in the course was far exceeded by that of Messrs. Braithwaite & Ericsson's beautiful engine from London. It was the lightest and most elegant carriage on the road yesterday, and the velocity with which it moved surprised and amazed every beholder. It shot along the line at the amazing rate of 30 miles an hour ! It seemed, indeed, to fly, presenting one of the most sublime spectacles of human ingenuity and human daring the world ever beheld.
>
> But the swift *Novelty*, notwithstanding her superior speed, did not win the prize. The stipulated sum of £500 sterling was awarded to Messrs. Stephenson's *Rocket*, which engine accomplished a distance of 70 miles (by running backward and forward on the Ramhill level), at a rate of 13½ miles an hour, with a train of cars loaded with rock, gross weight in motion, 17 tons. Much has been said *pro* and *con* respecting the fairness of the award made by the appointing judges and their determination to test a locomotive engine constructed solely for speed, and weighing only 2¾ tons, as if designed to carry goods at a slow rate. We feel no disposition to criticise the manner of conducting the trial, nor do we question the propriety of the award made by the judges appointed by the Board of Directors of the Liverpool & Manchester Railway ; but we deem it fair to our professional readers and to Captain Ericsson to record the following opinion, which speaks for itself, expressed by a reflecting mechanic : "The constructor of the *Novelty* exhibited far greater engineering knowledge than the constructor of the *Rocket*. In the first place, when Stephenson presented his locomotive-engine for trial, he depended on chimney draft to support the combustion in the boiler furnaces, while Ericsson, who had theoretically considered the matter, knew that sufficient air could not be supplied by natural draft. He therefore employed a blowing apparatus, which being operated directly by an engine, regulated the combustion to suit the speed of his locomotive-engine. So well was this blowing apparatus proportioned, that, while running at the rate of 40 miles an hour, the supply of steam seemed to be ample. Fortunately for Stephenson, Timothy Hackworth, the builder of the *Sans Pareil*, discovered the efficacy of the steam-blast in time to enable the constructor of the *Rocket* to apply the same before the termination of the competitive trial. Secondly, Ericsson, fully comprehending that durability of the steam-machinery called for absence of jarring motion, placed his engine-frame on four flexible carriage springs. Nor did he overlook the fact that the power of the engines must be applied in such direction as not to interfere with the free vertical action of the springs. Consequently, he resorted to such a combination that the connecting-rods operated in a horizontal direction. And by employing bell-cranks, he dispensed with connecting-rod guides, thereby obviating the thrust and heating inseparable from their employment, unless constantly lubricated. He avoided, at the same time, the use of horizontal cylinders, so strongly objected to by most engineers of that period. Stephenson, on the other hand, employed cylinders placed at an angle of about 45°, in consequence of which fully two thirds of the power of his engines lifted and depressed the carriage at each stroke. The resulting unavoidable tilting motion was aggravated by the necessary right-angular position of the driving-cranks, causing one side of the carriage to be lifted up while the other side was being depressed. The consequent violent rocking of the *Rocket* during the competitive trial was observed by all, and admitted to be a defect which called for some effectual remedy."

In the same year that the *Novelty* was tried, Ericsson constructed a steam fire-engine which was used in putting out a fire in the Argyle Rooms, in London. Another was sent to the Liverpool docks the next year, and a third was sent to Berlin. Ten years later, in 1840, the Mechanics' Institute gave its large gold medal to Ericsson for the best system of fire-engines.

Before leaving England, Ericsson applied the principle



THE LATE CAPTAIN JOHN ERICSSON.

[Reprinted from *Harper's Weekly* for March 16, 1889. Copyright, 1889, by Harper & Brothers.]

of condensing steam and returning the fresh water to the boiler on board the *Victory*, and in the steam vessel *Corsair*, built at Liverpool in 1832, he applied the centrifugal fan blowers now in use in most of the steam vessels in the United States. In 1834 he also used superheated steam in a steam-engine. It is also said that he used a form of link-motion in two locomotives in 1830. The link-motion is usually attributed to Stephenson, but he did not use it until 1843. In 1837 Ericsson built a tug-boat 40 ft. beam by 80 ft. long, with 3 ft. draft, having two propellers of 5¼ ft. diameter, and invited the British Admiralty to inspect it. The wise heads of that conservative body decided that as the propelling power was at the stern that it could not be steered.

On the advice of Commodore Stockton, Ericsson came to this country in 1839, and in 1841 began to build the *Princeton*. She is said to have been the first naval vessel that had her machinery below the water-line, out of the reach of hostile shot. Her engines were peculiar, the cylinders being made in the form of a sector of a circle, in which the pistons, which were connected to a shaft, oscillated. It was this ship that John Quincy Adams spoke of as "a gimcrack of sundry other inventions of Captain Stockton himself, was built under his directions, and is commanded by him." At a public exhibition of it one of the guns, the *Peacemaker*, burst and killed the Secretaries of State and of the Navy, and a number of other persons on board.

So full of wonderful achievements was the life of the remarkable man who is the subject of this article, and so multifarious were his achievements, that an account of them can be little else but a catalogue of what he did. This can be given perhaps best in his own words. When the great Centennial Exhibition, held in Philadelphia in 1876, was planned, through some oversight, Ericsson was not invited to exhibit his achievements, a neglect which apparently he resented. He therefore prepared a large book of 600 quarto pages in which his work was described. It was elaborately illustrated, with admirable engravings, and is printed on thick, heavy paper. The following introduction to it will give a better idea of this wonderful man's achievements than anything else could :

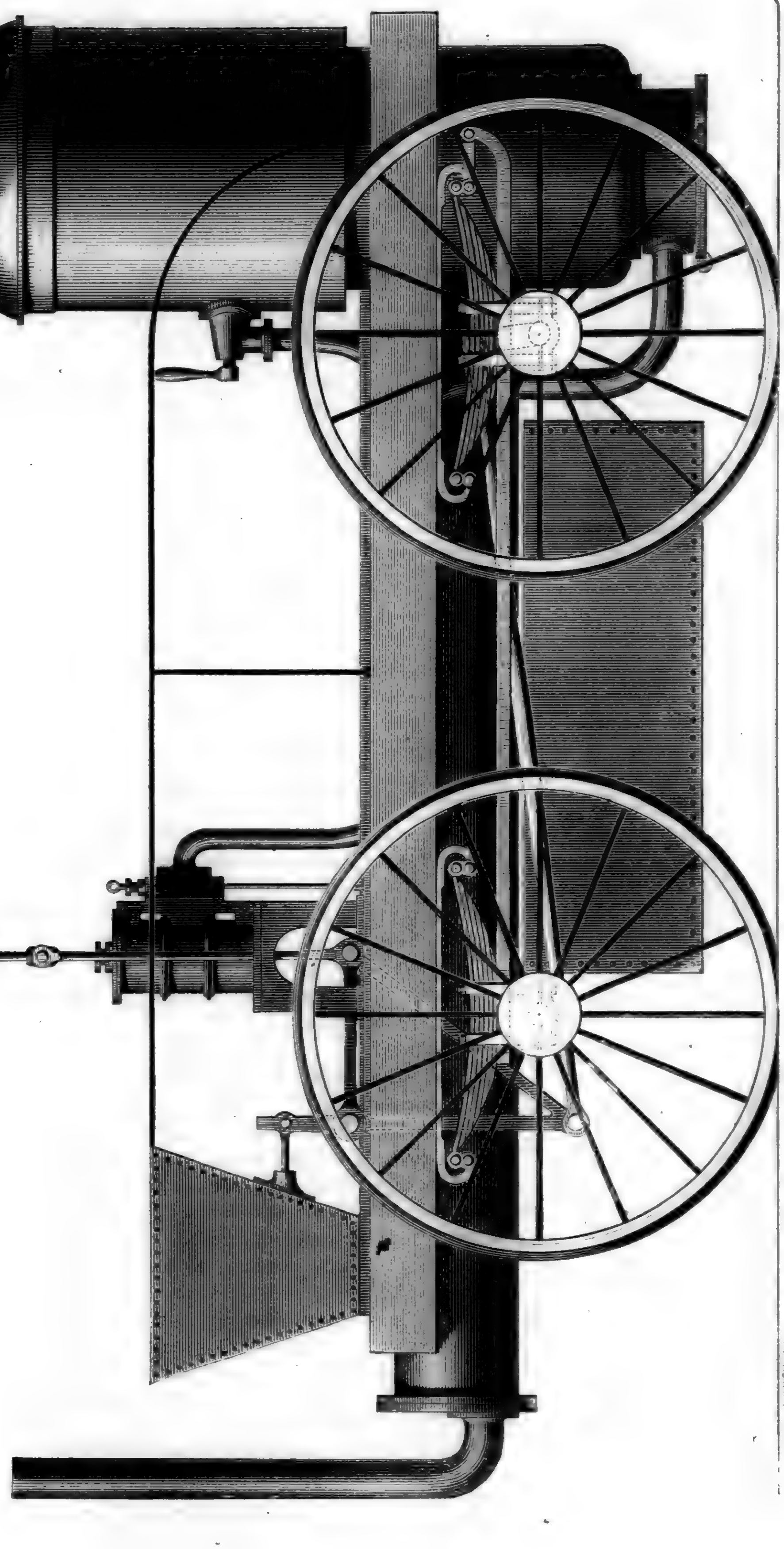
INTRODUCTION.

The Commissioners of the Centennial Exhibition having omitted to invite me to exhibit the results of my labors connected with mechanics and physics, a gap in their record of material progress exceeding one third of a century has been occasioned. I have, therefore, deemed it proper to publish a statement of my principal labors during the last third of the century, the achievements of which the promoters of the Centennial Exhibition have called upon the civilized world to recognize.

The nature of the labors referred to will be seen by the following account of philosophical instruments, engines, and other structures described and illustrated in this work—viz.: Apparatus for measuring the intensity of radiant heat at given distances. Instrument for measuring radiant heat emitted by concave spherical radiators within exhausted enclosures. Instrument showing the rate of cooling of a heated body within an exhausted cold enclosure. Instrument showing the rate of heating of a cold body within an exhausted heated enclosure. Instrument showing the rate of cooling of an incandescent sphere within an exhausted cold enclosure. Instrument for measuring the dynamic energy developed by radiant heat at different intensities. Actinometer, for measuring the temperature developed by solar radiation. Solar Calorimeter, for measuring the dynamic energy developed by solar radiation. Portable Solar Calorimeter, parallactic mechanism, for measuring the intensity of radiation from different parts of the solar disc. Instrument for measuring the radiant power of the solar envelope. Instrument for measuring the actual intensity of the sun's rays. Solar Pyrometer, for measuring the temperature of the solar surface. Apparatus for measuring the radiant intensity of flames. Instrument for measuring radiation from incandescent planes at different angles. Instrument for measuring the radiation from different zones of incandescent spheres. Calorimeter, for measuring the dynamic energy developed by radiation from fused iron. Apparatus for measuring radiant heat by means of the thermo-electric pile. Barometric Actinometer, for measuring the temperature developed by solar radiation. Apparatus for ascertaining the conductivity of mercury. Concave spherical radiator, for testing the accuracy of the solar pyrometer. Instrument for measuring the reflective power of silver and other metals. Rapid-indication Actinometer, for measuring the temperature developed by solar radiation. Apparatus for ascertaining the diathermancy of flames. Dynamic Register, for measuring the relative power of currents of water and vapor. Distance-instrument, for measuring distances at sea. Steam fire-engine, designed in 1841. Engines of the United States steamship *Princeton*, built at Philadelphia, 1842. Twelve-inch wrought-iron gun and carriage mounted on board the *Princeton*, 1843. Iron-clad cupola vessel, designed in 1854. Surface condenser for marine engines, patented 1849, built at New York Experimental caloric engine, built at New York, 1851. Caloric engine for domestic purposes, extensively introduced in Europe and America. The iron-clad turret-vessel *Monitor*, built at New York, 1861. Turret-vessels of the *Passaic* class, built at New York, 1861. Turret-vessels of the *Passaic* class, built at New York and other places, 1862. The *Monitor* engine, applied to the entire iron-clad fleet of the United States during the war. The turret-vessel *Dictator*, built at New York, 1862. Carriages for heavy ordnance, designed 1861, built at numerous mechanical establishments in the United States. Pivot-carriages of the Spanish gunboats, built at New York, 1869. Rotary gun-carriage and transit platform, built at New York, 1873. Gun-carriage for coast defense, designed 1861, built at New York. Independent twin-screw engines of the 30 Spanish gunboats, built at New York, 1869. New system of naval attack, published 1870. Movable torpedo, built at New York, 1873. Air-compressor for the transmission of mechanical power, built at New York, 1873. Solar engine, actuated by the intervention of steam, built at New York, 1870. Solar engine, actuated by the intervention of atmospheric air, built at New York, 1872.

The foregoing, it should be observed, relates to work carried out by me on American soil. It has no reference to my labors in England from 1826 to 1839 connected with locomotion, steam navigation, motive engines, and other branches of mechanical and civil engineering. Nor does it contain a *complete* enumeration of the original mechanical inventions carried into practice by me in the United States—models of which would have been presented at the Centennial Exhibition had its promoters desired me to furnish a record of my share in the progress of mechanical engineering during the last thirty-seven years of the first century of the Republic.

As our space only admits of a brief reference to the mechanical inventions adverted to and not described or illustrated in this work, the following statement is appended, furnishing an outline of the principal structures omitted—viz.: Engines of the twin-screw steamship *Clarion*, built at New York, 1840, consisting of two vertical cylinders, placed fore and aft in the vessel, actuating the cranks of the screw-shafts by inclined connecting-rods. Vertical single engines, actuating twin-screws, built at New York, 1842, applied to several freight vessels on the Delaware & Raritan Canal. Single horizontal back-action engine, built 1843, applied to the United States screw-steamer *Legaré*. Inclined screw-engines, built 1843, applied to the steamship *Massachusetts*, the steam cylinders of which were placed near the deck of the ship's sides, secured to diagonal timbers bolted to the planking. Centrifugal suction-fan, built 1843, operated by an independent engine, for producing draft in marine boilers by *drawing* the air through the furnaces and flues, and forcing the products of combustion into the chimney. Inclined engines, built 1844, applied to the bark *Edith*, the connecting-rods operating at right angles to each other and coupled to a common crank-pin, in the propeller shaft. Vertical engines, built in 1844, applied to the twin-screw vessel *Midas* (the first screw-vessel to round the Cape of Good Hope), the power being transmitted to the propeller shafts by vertical connecting-rods actuated by horizontal beams placed transversely under the deck. Vertical engines applied to numerous screw-vessels employed on the coast and inland waters of the United States, the cylinders being placed perpendicularly above the propeller-shaft, the connecting-rods acting downward—a form of engine now employed in nearly all sea-going steamers, but at that time (about 1844) severely criticised by marine engineers. Engines of the twin-screw ship *Marmora*, built 1843, consisting of vertical steam-cylinders, which, by means of beams



THE "NOVELTY" LOCOMOTIVE ENGINE.

DESIGNED BY JOHN ERICSSON AND BUILT BY JOHN BRAITHWAITE, 1829.

working under the deck and vertical connecting-rods, imparted independent motion to the propeller-shafts. Horizontal high-pressure and condensing engine of the twin-screw steam-tug *R. B. Forbes*, built 1844, provided with detached condenser and air-pump actuated by an independent engine—a vessel which, during a series of years, rendered valuable service on the coast of Massachusetts by towing and relieving ships in distress. Compound stationary engine, actuated by very high pressure, in which the steam was expanded to the utmost extent, elaborately described by Dr. Lardner, who devoted much time to its theoretical consideration. Horizontal engine applied to the screw-vessel *Primero*, actuated by a mixture of steam and atmospheric air. Stationary engines actuated by highly superheated steam, the pistons of which were single-acting and thoroughly protected against the injurious effect of high temperature. Experimental street car, propelled by a double caloric engine. Hoisting machines, actuated by cold compressed air, applied to several warehouses in New York. Small motors, actuated by cold compressed air, successfully applied to the sewing machines of a large establishment in New York, intending to establish the fact that the present injurious physical exertion of sewing-women may economically be dispensed with.

Regarding the descriptions and illustrations of the caloric engines contained in this work, it is proper to observe that they relate only to some of the engines which I have built, at least 10 different types, unlike these described, having been constructed and practically tested. Nor have I yet wholly suspended the labors connected with this safe and economical engine. The fact that it requires no water, and that its principle is not incompatible with the desirable employment of a very high temperature—apart from the important circumstance that the use of atmospheric air admits of returning at each stroke, by the process of regeneration, the heat not converted into mechanical work during the previous movement of the working piston—justify continued endeavors to perfect this remarkable motor. J. ERICSSON.

New York, September 1, 1876.

The magnitude, variety, and importance of the work that was done by him makes comment and criticism of it almost impossible. The problem of the caloric-engine engrossed much of his time, and his labors in that direction were spread over many years. It must be admitted, however, that the practical results of this work were insignificant compared with the work that was done. Some thousands of the smaller engines have been built and are now in use, but they have never been used for any considerable time where much power is required. Ericsson was an inventor and engineer and not a business man, and it seems now as though his life and his labors would have been more useful if his own capacity had been supplemented with the assistance of a clear-headed and energetic person with the commercial faculty of utilizing the discoveries of the inventor.

The story of the memorable contest of the *Merrimac* and the *Monitor* has often been told. No event that ever occurred seems to have about it so much of the elements of romance and tragedy, and no story that has ever been written was so full of thrilling interest. Whether it did or did not change the destiny of a nation, need not be discussed now, in the light of the lustre which it shed on the man whose deeds are being recited here, quite too briefly to do justice to his greatness.

Of the man himself little need be said. He devoted his life to his work, and lived almost like a recluse. He avoided society because it would absorb his time, which he seemed to value more than fame or money. He appeared, too, to shun notoriety, and he directed, only a short time before his death, that his diary, which had been kept through many years, should be destroyed ; this wish was carried out, causing a loss much to be regretted.

He was a widower and childless, so that his life was a lonely one, and it may be that as the weight of years was laid slowly but surely on his shoulders, there came with it that longing which comes to many, perhaps at last to all, for rest, eternal rest.

NEW PUBLICATIONS.

REPORT OF THE COMMISSIONERS ON SOURCES OF WATER SUPPLY FOR THE CITY OF SYRACUSE, N. Y. New York ; printed by the *Engineering and Building Record* Press.

This is a carefully prepared and very full report of an examination made of the water-sheds of several lakes and rivers in Central New York, which seemed available for the new supply which the rapid growth of Syracuse has made necessary. The Commission has decided to recommend the drawing of the new supply from Skaneateles Lake, and the object of this report is to set forth the reasons for this decision ; and this has been done in a very complete way.

The principal and most important part of the book is the report of the Engineer, Mr. J. J. R. Croes, who made an examination of the ground, on which the recommendations of the Commission are based. Mr. Croes's report is full and exhaustive, covering the ground very completely, and leaving very little further to be said on the subject.

The report is accompanied by a number of maps showing the different water-sheds, and also the system of mains and distributing pipes at present existing in the city.

THE DICKSON MANUFACTURING COMPANY, ILLUSTRATED CATALOGUES: 1. LOCOMOTIVES. 2. BOILERS. 3. HOISTING ENGINES AND MINING MACHINERY. 4. MACHINERY FOR THE TRANSMISSION OF POWER. Scranton, Pa.; Issued by the Company.

From a modest beginning in a small shop for the construction of mining machinery, in 1855, the business of this Company has grown to such proportions that it now operates three large shops, the Penn Avenue and Cliff Works, in Scranton, and the Machine Shops, in Wilkesbarre, and no less than four catalogues are needed to set forth the different classes of work done by the Company. The Penn Avenue shops are used for the construction of engines and general machinery ; the Cliff Works are specially devoted to the construction of locomotives, while in the Wilkesbarre Shops mining machinery, boilers, and car wheels are made.

The catalogues are very complete, that of locomotives especially covering every class of engines in ordinary use, with a number of special locomotives for mining work and for use in large manufacturing establishments and other special purposes. The excellence of the work done by this Company requires no special mention, as its reputation is well established. The catalogues of hoisting and mining machinery and of machinery for the trasmission of power also cover a wide range of work, and are very complete and well illustrated. In boiler work the list includes locomotive boilers and boilers of all description for stationary, mining, and other work.

SOUTH BRUNSWICK TERMINAL RAILROAD COMPANY: PROSPECTUS. New York ; Leo Von Rosenberg, Publisher.

This elaborate prospectus sets forth the project undertaken by three companies substantially under the same management—the South Brunswick Terminal Company, the South Brunswick & Cordele Railroad Company, and the Brunswick Harbor and Land Company. The object of these companies is to build up a port at South Brunswick,

opposite the present town of Brunswick, Ga., and to connect this port with the railroad system of the South by a line some 150 miles in length, furnishing a new outlet to the Georgia Central and other connecting systems. The excellence of the harbor of Brunswick has often been set forth, and the lands chosen by the South Brunswick Company have the advantage that with comparatively little docking a depth of 21 ft. of water can be obtained, directly in front of the new town. The prospectus sets forth very fully the advantages of the proposed plan. It is illustrated by a number of photographs, and is gotten up in a style very much superior to most books of the kind. It has the further merit that the maps accompanying it are correct and are most admirably drawn and engraved, the credit for which is due to Mr. Von Rosenberg, the Engineer and Publisher.

ABOUT BOOKS AND PERIODICALS.

The Gazeta Electrika, published in St. Petersburg, Russia, is the latest addition to the list of periodicals devoted to electrical science and engineering. It gives current electrical news and illustrated descriptions of new electrical apparatus. It is in the Russian language and is edited by Mr. Alphonse Schtchawinsky.

The Overland Monthly for March has articles on American Isthmus Canals, by William L. Merry; some reasons for the decline of American Deep-sea Commerce, by John Totyl; Frontier Life in the Army, by A. Ebermayer, and a study of the extraordinary growth of the city of Los Angeles, by C. H. Shinn The article on Isthmus Canals is a brief but interesting summary of the present situation of the rival projects of the Panama and Nicaragua Companies.

The Century Magazine for March contains articles on the Use of Oil to Still the Waves, by Lieutenant W. H. Beehler, U.S.N., and a popular account of the Electric Motor, by Charles Barnard. Mr. Kennan continues his very interesting series by an account of the Trans-Baikal, hitherto a part of Siberia almost unknown to us, even by name, and now described for the first time.

Competition and Trusts and the Foundation Stones of the Earth are among the articles in the Popular Science Monthly for March, which gives also an interesting account of Glass-making and an essay on Natural Science in Elementary Schools, by J. M. Arms.

In the Magazine of American History for March, attention is called to the remarkable fact that as late as 1846 an American author spoke of the possible discovery of a water-way from Hudson's Bay to the Pacific, by way of the Oregon River. This exhibition of geographical ignorance seems almost incredible to us now, but is a fact.

The Journal of the Military Service Institution for March contains the prize essay, for this year, on Organization and Training of a National Reserve, by Lieutenant A. C. Sharpe; also the essay on the same subject, which received honorable mention in the competition, by Major W. C. Sanger. Other articles are on Field Manœuvres, by Major E. Nash, and Revision of the Tactical Gaits for our Cavalry, by Colonel R. P. Hughes. There are also some interesting translations from the German, and the usual Military Notes, Reviews, and Exchanges.

Charles Francis Adams, President of the Union Pacific Company, is the author of a valuable paper, in Scribner's Magazine for April, on the Prevention of Railroad Strikes. This paper was prepared by Mr. Adams in June, 1886, and submitted to several of the leading officials engaged in the management of the Union Pacific Railroad Company. It drew forth much criticism, but was finally laid aside, and its suggestions were not carried into practice.

The Building of an Ocean Greyhound is the subject of a very interesting article by William H. Rideing, in the same number. The article is fully illustrated from photographs taken in the Clyde ship-yards, showing the various stages in the building of a great ocean steamer.

BOOKS RECEIVED.

Geological and Topographical Map of the New Boston and Morea Coal Lands in Schuylkill County, Pa.: by Benjamin Smith Lyman, Assisted by Amos P. Brown and J. S. Elverson. Philadelphia, January, 1889; issued by Benjamin S. Lyman. This is a very fine piece of local map work, made with special reference to mining engineering.

Journal of the New England Water-Works Association; March, 1889. New London, Conn.; published by the Board of Editors, Professor George H. Swain and Walter H. Richards.

Reports from the Consuls of the United States to the Department of State; New Series No. 1, January, 1889. Washington; Government Printing Office.

Occasional Papers of the Institution of Civil Engineers. London, England; published by the Institution. The present installment of these papers includes the Failure of the Kali Nadi Aqueduct, by Walter Hampden Thelwall; Hurst's Triangular Prismatic Formula for Earthwork, by James William Smith; Manufacture of Oil-gas on the Pintsch System and its Application to the Lighting of Railroad Carriages, by Gilbert M. Hunter; Strength of Bessemer Steel Tires, by John Oliver Arnold; Preliminary Survey in New Countries, by Theodore G. Gribble; Rapid Surveying, by Francis D. Topham; Practice in Surveying in the Australasian Colonies, by S. K. Vickery; Witham New Outfall Channel, by John Evelyn Williams; Abstract of Papers in Foreign Transactions and Periodicals.

Friction Brake Dynamoters: by William Worby Beaumont. London, England; published by the Institution of Civil Engineers.

The Friction of Locomotive Slide-Valves: by John A. F. Aspinall. London, England; published by the Institution of Civil Engineers.

Anales de la Sociedad Cientifica Argentina; Entregas 1, 2, 3, Tomo XXVI. Buenos Ayres; issued by the Society.

Sixth Annual Report of the Railroad Commissioners of Kansas, for the Year ending December 1, 1888: Almerin Gillett, Albert R. Greene, James Humphrey, Commissioners. Topeka, Kan.; State Printer.

Seventeenth Annual Report of the Water-Works, Bay City, Michigan: E. L. Dunbar, Superintendent. Bay City, Mich.; issued by the City.

Address of the President of the Engineers' Club of Cincinnati at the Annual Meeting of the Club, December 5, 1888: Colonel William E. Merrill, President. Cincinnati, O.; issued by the Club.

Herzogliche Technische Hochschule Carolo-Wilhelmina zu Braunschweig: Programm für das Studienjahr 1888-89. Brunswick, Germany: F. Vieweg & Son.

Hornig's Direct Power-Steering System: Julius L. Hornig, M.E. Jersey City, N. J.; E. S. Wells, Agent and Manufacturer.

CATALOGUE OF SCALES, RENSSELAER SCALE WORKS. Lansingburg, N. Y.; Arnold & Rowe, Proprietors.

THE TAPER-SLEEVE PULLEY WORKS: CATALOGUE AND PRICE-LIST. Erie, Pa.; issued by the Works.

THE EXCELSIOR IRON WORKS COMPANY: CATALOGUE. Cleveland, O.; issued by the Company.

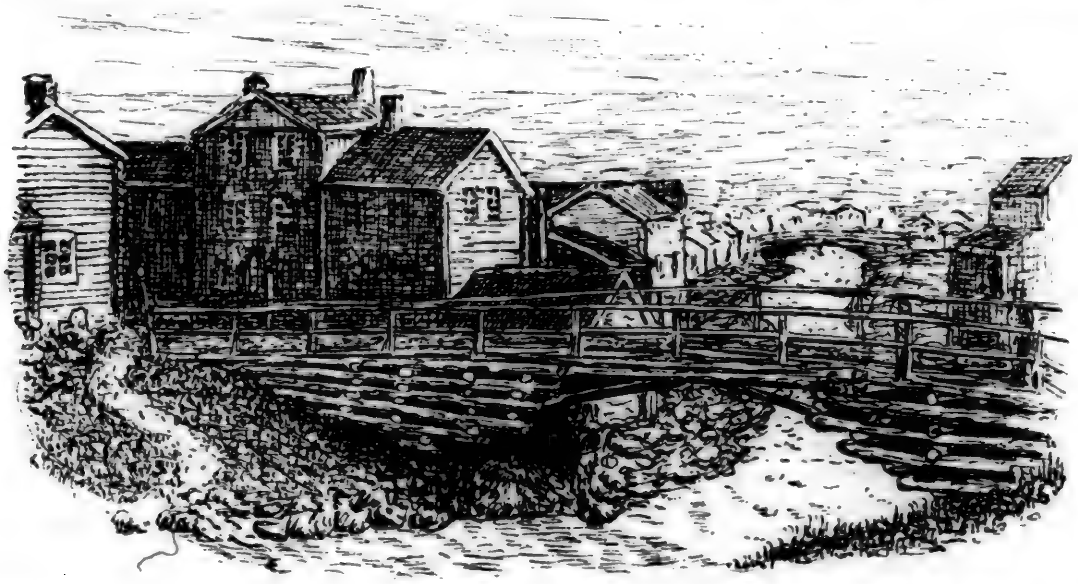
THE BRYAN MANUFACTURING COMPANY. WHEELBARROWS: CATALOGUE. Bryan, O.; issued by the Company.

CATALOGUE OF IMPROVED WOOD-WORKING MACHINERY. Williamsport, Pa.; issued by the Williamsport Machine Company.

WOODEN CANTILEVER BRIDGES.

To the Editor of the Railroad and Engineering Journal:

APROPOS of your cut and description of a bridge recently built in Sikkim (published in the February JOURNAL, page 66), I send you the accompanying sketch of a bridge at Röraas, Norway, which you will find illustrated in Du Chaillu's "Land of the Midnight Sun." He describes it as follows: "The Hitter River flows through the center of the town, the two parts being connected by picturesque wooden bridges of construction peculiar to Norway. The logs are supported by the filling at the ends, and also by the braces," as the following engraving shows.



Ethnologists used to say that there was a great deal of Tartar blood shown in the Swedes; it was recognized in their descendants about Philadelphia. Du Chaillu, in his first volume, speaks of a race of men from beyond the Black Sea, who reached Sweden by the way of Gothland, about the year 1200 A.D., whose descendants returned to Asia; perhaps they were Civil Engineers. *Quien Sabe?*

A. V.

CITY ELEVATED RAILROADS.

To the Editor of the Railroad and Engineering Journal:

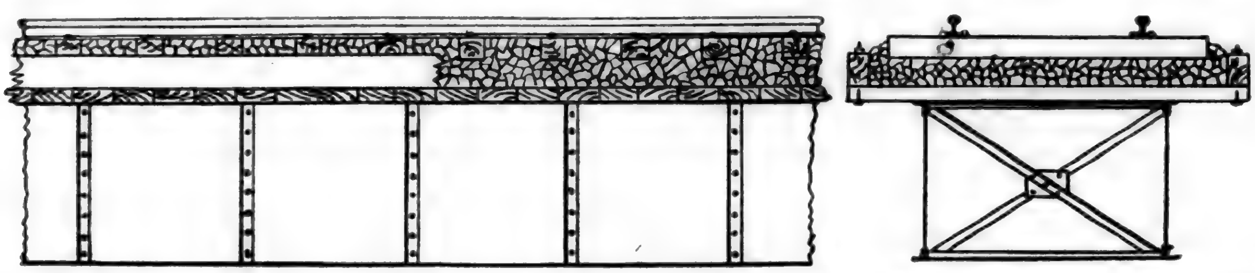
I HAVE been very much interested in the various plans and schemes for rapid transit, and, while they make very good reading and sound well, yet there is apparently no immediate prospect of anything better than the present elevated roads.

Any practical plan for either underground roads or elevated stone structures through the blocks will take several years to develop and complete. In the mean time, which will cover at least the next 10 years, it seems that the best plan of elevated structure should be used and such measures for safety and comfort adopted as may be had within a reasonable limit of expense. It has been a matter of some curiosity to me as to whether any tests of the tension members of the Sixth Avenue Elevated Railroad spans have ever been made and what the effect of 10 years of almost constant vibration upon them would be.

It looks as if the Manhattan Elevated Railroad Company were taking very heavy chances with that part of its system, and while the movement of trains and service is admirable, I do not like the plans of the structures.

A plate girder is generally recognized as the best style of bridge for short spans, and such girders are used largely in Brooklyn, where the traffic is much lighter.

The plan enclosed is of a plate girder with the track carried on broken stone ballast, which in turn rests on a continuous platform of wooden planks laid crosswise; a guard is bolted along the outer end of planking to prevent the ballast dropping off into the street. The usual inner and outer tie and wheel guards may be bolted on the ties. The interposition of several inches of broken stone between the tie and the planking will do much to deaden the noise of the trains.



The joints supported on the broken stone well tamped will not pound as they do at present, which will save the rails largely. The additional weight—say 1,000 lbs., per running foot—will be dead load, and will be fully offset by the decreased effect of moving load. There is no more necessity of bolting the ties down to the bridge here than there would be on a stone viaduct. The result would be a much smoother running track, less noise, longer life of rails and ties, and, with the substitution of the plate girder, a much safer bridge.

I do not know whether this plan has ever been proposed or not. There is nothing remarkable about it and nothing but what is very easily demonstrated. F. NEARING.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

I.—OLD AND NEW GUNS.

From the bundle of wrought-iron staves, hooped together like a barrel, that figured as the first cannon, to the latest production of Krupp or Armstrong, the step is almost as great as from the original arquebuse or matchlock to the automatic wonder of Maxim. The growth of the cannon, as of the small-arm, has been gradual and attained only at the expense of patient investigation and countless experiments carried on through many centuries.

It is not proposed to enter into the details of early cannon construction, or even into a long history of the growth of heavy ordnance, prior to the introduction of the rifle. It is sufficient to say that the improvement in the construction of cannon kept pace with the development of the mechanical arts, a knowledge of the metallurgy of gun materials, and with the inventive genius of mankind.

It would hardly be safe to define a high-power gun as one that could throw a projectile with a high initial velocity. The projectile of such a gun must not only start with a high velocity, but it must be able to maintain it through a flight of thousands of yards against tremendous atmospheric resistance, and reach its object with still a large amount of stored-up energy. In other words, there must be a proper relation between the caliber of the piece and the weight of its projectile. The work a missile will do either in overcoming the resistance of the air, or of material obstacles, is always a question of $M V^2$.

The distinguishing characteristics of a typical piece of modern ordnance may be summed up in the statement that it must be a rifle, loading at the breech, have a powder chamber with a capacity for a charge of about one-half the weight of the shot, a length of bore of at least 30 calibers, and be capable of imparting to its projectile, weighing from four to five times as much as a round shot of like caliber, an initial velocity in the neighborhood of 2,000 ft. per second. Remembering that the first rifled guns used a projectile of but little more than twice the weight of a corresponding round shot, a powder charge of about one-tenth the weight of the projectile, and imparted an average initial velocity of less than 1,500 ft. per second, the magnitude of the improvement may be understood.

Leaving out of consideration for the present the question of the material to be employed in the construction of the gun, only granting that it shall possess a reasonable degree of strength, it can easily be seen that the problem before the artillerist has been how to obtain this greatly increased initial velocity without excessive pressure in the bore of the piece. Clearly this can be attained only by a change in the character of our projectile force. While the whole moment of force expended upon the projectile must be much greater than heretofore, it must be less violent in its action and longer continued.

With the powder used in heavy guns up to a comparatively recent date the grains were of medium size and of moderate density. When a charge of powder of this description is ignited, a greater part of it is converted into gas before the inertia of the projectile is overcome. If the charge be large or the projectile heavy, the pressure becomes enormous. To attempt to get a velocity of 2,000 ft. with such powder, from a rifle projectile of any kind, where all escape of gas is cut off, would be impossible with any gun metal we now possess.

The solution of the problem has been reached through the invention of slow-burning powders. This quality of slowness of burning may be obtained either by increasing the size of the individual grains or by giving them greater density, or by both. The details of the manufacture of this powder, which is said to be of German origin, are kept secret, but in addition to increased size of grain and greatly increased density, the process is supposed to involve a slight change in the proportion of the ingredients and in the methods of their manipulation. The grains are perforated through the center, and of such shape (usually a flat hexagonal prism) that they form, when placed together in a cartridge, a solid mass, the perforations in the individual grains forming continuous passages through the entire length of the cartridge, and serve to communicate the flame throughout the charge.

The combustion of a charge of dense, slow-burning powder is quite a different thing from the explosion of one of small grains and low density. During the first instants after ignition, and until the gases given off acquire considerable tension, the burning of the compact grains proceeds with relative slowness. The gas developed in these first instants is sufficient to *start* the projectile. Thereafter, although the powder gases rapidly increase in volume, the space behind the projectile increases in something like the same ratio, so that the shot leaves the bore under the impulse of a long, steady push rather than of a sharp blow.

II.—BREECH-LOADERS AND MUZZLE-LOADERS.

From what has been said it is easy to understand why our modern rifle must be a breech-loader. To obtain the results of high velocity and great momentum enormously large charges of powder are required. To accommodate a charge of this kind a chamber of about one-fifth greater diameter than the bore is necessary, and the advantages of breech-loading in this connection are obvious, while to secure from this charge its full effect the projectile must be held within its grasp until the entire mass is consumed and converted into gas, which means simply a length of bore quite double that of the old-time pieces. To attempt to load a piece of such length from the muzzle is practically out of the question.

This question of muzzle *versus* breech-loading is an old one among artillerists. The war between the two systems began with the introduction of the first rifled ordnance, and has been waged up to a very recent period.

The makers of the first cannon must have had an idea of the advantages of loading from the breech, for we find among the first guns fabricated pieces of this description. The mechanism of these pieces was exceedingly simple.

The square breech-block, which contained the powder and projectile, fitted into a vertical aperture at the rear end of the bore, and was provided with handles for lifting in and out. Probably the mechanical difficulties in the way of construction prevented its general adoption.

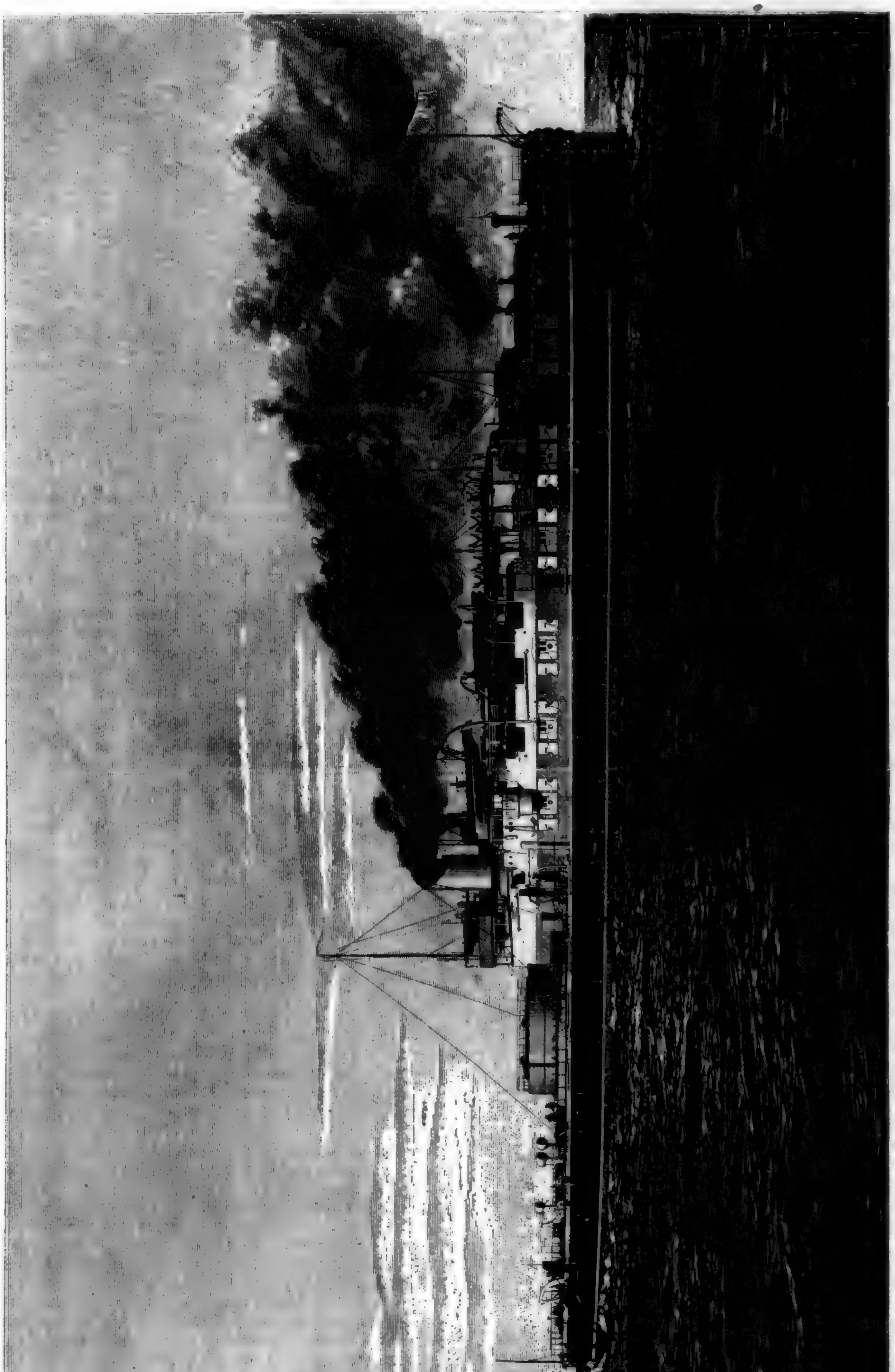
So far as we know the first rifled cannon made was a breech-loader. Armstrong, the great English gun-maker, and the pioneer in built-up ordnance, adopted the idea, and from 1855 to 1865, constructed a system of breech-loading guns, beginning with a 3-in. field-piece and reaching, at the latter date, a 7-in., 82-cwt. gun. For some reason, supposed to be the difficulty of constructing satisfactory breech mechanism in the larger calibers, he now abandoned the breech-loading system altogether and went back to muzzle-loaders.

During the 20 years that followed 1865, while with Whitworth in England, and with all the Continental gun-makers, the breech-loading system had become firmly established, the English Government went on building up a system of muzzle-loaders, until it had reached the great 100-ton gun—the Royal Gun Factory at Woolwich following, with slight modifications, the lead and system of Armstrong. As late as 1880 an English military writer, speaking of the relative merits of their own and the German system of guns, settles the whole question in their own favor by saying, "the question of breech-loading steel guns is finally and forever set at rest as far as England is concerned."

The question was not settled, however, and in 1884 we read that the first issue of the new 12-in. breech-loading guns was being made in England. Since that time the muzzle-loader has been relegated to the scrap-heap, so to speak, and no gun-maker to-day would think of building a gun on this system any more than he would seriously consider the casting of a smooth-bore.

III.—GUN MATERIAL.

Up to the time of the appearance of rifled artillery, bronze and cast-iron were the cannon metals the world over. It was a long time before the fact that these well-tried metals were unsuitable for guns under the changed conditions of strains and powder-pressure would be accepted by metallurgists and military experts. Even to-day



THE NEW ENGLISH BATTLE-SHIP "VICTORIA."

there are not wanting advocates for cast-iron as a material for rifled ordnance.

This battle of the metals has been quite as long and bitter, and the dead and disabled even more numerous than in the contest between breech-loader and muzzle-loader, as the scrap-heap and repair-shop of any ordnance proving-ground will show.

The first experiments with rifled guns were made with cast-iron pieces, both from motives of economy and from lack of knowledge of the capabilities of the metal.

England began with her cast-iron Lancaster gun, but with results so unsatisfactory that under the leadership of Armstrong a system of built-up guns, wholly of wrought-iron, was begun and has been persisted in up to a very recent period, yielding only under the pressure of costly experience some years ago to the substitution of steel for wrought-iron for the inner tubes. The guns of latest pattern and those now in course of fabrication are wholly of steel.

Prussia began the construction of rifled ordnance with cast-iron guns, first of muzzle-loaders and later of the breech loading system. But the metal was soon discovered to be unreliable, and since 1867 Krupp steel has alone been used in gun construction. From small beginnings the steel works of Krupp, at Essen, have grown to gigantic proportions and this establishment now furnishes not only all the ordnance for Germany, but supplies guns in large numbers to other powers.

Russia began the remodeling of her ordnance in much the same way as Prussia. When cast-iron was discarded, she had recourse to Krupp's breech-loading steel guns, but later founded an establishment of her own modeled upon that at Essen.

Of Italy we read much the same story of attempts to utilize old cast-iron guns, and the belief in cast-iron was held for a long time. A 100-ton cast-iron gun, hooped with steel, constructed not long since testifies to this belief. For the armament of their monster iron-clads, however, she has provided guns from the establishments of Armstrong and Krupp.

More than any other European power France has had a long and costly experience in her endeavors to use cast-iron either alone or in part in rifled-gun construction. Beginning with unbanded cast-iron pieces, the first efforts in the direction of obtaining additional strength were the employment of a single band or reinforce of steel over the breech of the gun. The addition of a second was the next improvement. This was followed by the insertion of a steel tube in the bore. Finally, resort has been had to all steel guns.

In the matter of gun-construction, Austria has followed different lines. Experience having shown that ordinary bronze or gun-metal did not possess sufficient hardness for rifled ordnance, the improvement of this metal was undertaken by General Uchatius, with the result of what is now known as "steel-bronze." There is no steel in the composition of this metal, its peculiarity consisting in the manipulation of the material. The gun of ordinary bronze is cast in an iron mold, and on a core of solid copper. This is then bored out to a size less than the finished bore by about a quarter of an inch. A series of hardened steel punches, or cones, are then forced through the bore by hydraulic pressure, each cone being slightly larger than the preceding one. By this means the interior of the bore is condensed or hardened. It was expected that guns of large caliber could be constructed upon this principle, and efforts were continued until the accidental death of the unfortunate inventor put an end to the experiments. Austria has now adopted guns of Krupp manufacture.

In the United States, owing to the superior quality and strength of cast-iron guns of the Rodman pattern, it was believed up to a very recent date by many American artillerists, and is still believed by some, that guns of American iron cast upon the Rodman principle—that is, cast hollow and cooled from the interior—could withstand even the powerful pressures rifled ordnance is called upon to bear, but the idea has never been carried beyond the exprimental stage except in connection with other metals.

In the matter of changing cast-iron smooth-bore guns into rifles, an extensive scheme of conversion was undertaken soon after the war. It was proposed to utilize our 8, 10, and 15-in. Rodmans by reboring and inserting wrought-iron tubes, reducing the calibers to 6, 8, and 12 in. respectively. Something over 100 guns of the two lower calibers have been converted, first by using a wrought-iron inner tube and later by one of steel.

A number of experimental guns of cast-iron, reinforced with steel or steel wire, are now under construction.

Built-up breech-loading guns of steel, of 6, 8, and 10-in. caliber have been constructed for the Navy, and one 8-in. Army gun of the same character has been finished and given remarkably good results in its trial.

It might be added that the early efforts to use cast-iron rifles, reinforced with a band of wrought-iron at the breech, were unfortunate. A large number of Parrott guns of this description, of 6, 8, and 10 caliber, were fabricated soon after the breaking out of the late war, and issued to both the Army and Navy. The bursting of a number of these guns in the trenches in Charleston Harbor, and later the bursting of five or six on the fleet while bombarding Fort Fisher, causing great loss of life, condemned them at once to the scrap-heap.

The latest attempts in gun-construction in this country have been in the direction of cast-steel guns. Two of these guns, of 6-in. caliber, have been cast within the past 18 months. One, of Bessemer steel, cast at Pittsburgh, was tested a few months ago at the Annapolis proving-ground, and burst at the second round. The second, of open-hearth steel, known as the Thurlow gun, was, as is well-known, subjected to trial at the same place, a short time ago, and withstood the statutory test of ten rounds satisfactorily. The question of endurance of cast-steel guns is not, however, considered as settled by practical artillerists by this trial.

In conclusion it may be said that the experience gained by 30 years of experiment goes clearly to show that steel in some form or another—cast and forged, oil-tempered, compressed, or in the form of wire, in various combinations, is to be the gun-metal of the future.

(TO BE CONTINUED.)

THE LATEST ENGLISH BATTLE-SHIP.

THE accompanying engraving, from the London *Engineer*, shows the latest battle-ship added to the English Navy. This is the *Victoria*, built by Sir W. G. Armstrong, Mitchell & Company, and launched at Elswick, April 9, 1888. The engraving is from an instantaneous photograph, showing the ship under steam.

The *Victoria* is built of steel, and the principal particulars concerning her are as follows: Tonnage displacement, 10,470; indicated horse-power, 14,244; length, 340 ft.; beam, 70 ft.; mean draft, 26 ft. 9 in.; speed, 17.3 knots, developed during speed trials in June, 1888; complement, 550 men.

The armament consists of two 110 ton (16¼-in.) breech-loading guns; one 29-ton (10-in.) gun; twelve 5-ton (6-in.) guns; twelve 6-pounder and nine 3-pounder rapid-fire guns—36 guns in all. The 110-ton guns are 43 ft. 8 in. long; their heaviest projectile weighs about 1,800 lbs. and the powder charge is 960 lbs.

The *Victoria* is rated as a first-class battle-ship. She is protected by a belt of 18-in. compound armor, extending about half the length of her hull; and rising 2 ft. 6 in. above the water. There is a covering deck, which extends to the bow and stern, where it is 3 in. thick. The turret —in which are the two 110-ton guns—is plated with 17-in. armor, and the guns will have an arc of fire from right ahead round the bow. Behind the turret is the conning tower, on top of which is a deck house. The mast of steel is really used as a derrick post for hoisting out boats, etc. A 29-ton breech-loader is carried right aft.

The engines were built by Humphreys & Tennant. The cost has been £817,841, or over $4,000,000 in all.

The *Victoria* is a much heavier ship than the *Texas*, the largest ship now under construction for our own navy. The *Texas* is 290 ft. long, 6,300 tons displacement, and carries 12-in. armor; her heaviest guns will be 12 in. Both vessels will have about the same maximum speed, but the *Texas* will have a greater cruising range.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 127.)

CHAPTER XXXIX.

THE BOUHEY SPRING HAMMER.

This hammer, which is shown in figs. 123 and 124, is composed of a frame and an anvil-block cast in a single piece. The upper part of the frame carries the pulley *B* with a tightening pulley *C* and a brake *D*; at about the middle of its height it carries a crosshead *E*, provided with a spring *F* and jointed arms *G G*, and below a steel block *H*.

The shaft of the main pulley *B* carries in front the fly-wheel or crank-plate *P*, on which is fixed a crank-pin carrying the connecting rod *I*, the lower end of which is attached by the clamp *J* to the elliptic or plate spring *F*; this spring is joined at its extremities to the jointed arms *G G* and through them to the crosshead *E*. At the lower part of the crosshead is the hammer-lock *K*, which is keyed fast.

This crosshead thus receives an up-and-down motion; it moves in guides bolted to the frame. The hammerman controls the working of the hammer by means of a hand-lever *L*. By pressing on this lever the tension pulley *C* is thrown into position, the belt is tightened and the hammer works; when the handle is released, the brake acts and the movement is stopped.

While the speed of the driving-pulley *B* may be constant the speed of the hammer—that is to say, the number of blows which it strikes in a given time—may be varied at the will of the hammerman by his action on the lever *L*. This speed depends on the tension thrown upon the belt, because we obtain, on the one hand, a certain slipping of the belt which reduces the speed of the main pulley, and consequently the number and force of the blows, while with full pressure the speed of this pulley corresponds to that of the belt and the hammer works with its full force.

In order to have full command of this hammer it is best to use an intermediate shaft provided with tight and loose pulleys, so that when the hammer is not in use the driving pulley is not kept running to no purpose.

The connecting rod *I* presents one peculiarity of construction; it is composed of three parts, the middle portion being threaded at each end and joined to the others by nuts; the threads are right and left-hand so that the length of the rod can be modified at will by turning the nuts. In this way the length of the rod can be varied according to the thickness of the forging, that is to say, the approach of the hammer to the anvil-block can be regulated, the full stroke being still preserved, so that the force of the spring can be fully developed.

The force obtained with this hammer is greater than is due to the speed, the principal agent being the elastic force of the spring, which has the form of the arc of a circle. In following the action of this hammer it will be seen that when it is at the end of its stroke, and the lever begins to act upon this spring, the latter not being immediately followed by the hammer—the inertia of which offers a certain resistance to the motion—experiences a certain bending force; immediately the whole striking mass is put in motion and the hammer not only follows the spring, but jumps upward, so to speak, and produces in the spring its maximum deflection; then the crank commences its descending movement, and the spring, having reached its maximum deflection, and finding itself suddenly reversed, throws down the hammer upon the forging with a high speed, which is not only that of the lever, but also the speed of the spring itself under its reaction.

Under the influence of the shock, the hammer rises suddenly, and the more easily that the spring leaves it full liberty; it is thus free from the contact with the forging, which, with certain classes of hammers, continues for a perceptible time, and which has a cooling action upon the iron.

The total force of the blow is therefore much greater than that resulting from the weight of the crosshead, while the consumption of power is reduced in the same proportion.

When the hammer is ready to work it is not necessary that the blow should touch the anvil at its lowest point, the space between the two varying according to the force of the hammer. To regulate the distance the hammer is worked at about one-half of its normal speed, and at this speed it should touch the forging placed upon the anvil lightly; running at full speed the crosshead will thus produce a maximum effect by striking the most forcible blow. The countershaft should be placed in such a way as to leave very little space between the belt and the tightening pulley. The belt should be loose enough to slip on the pulley, without, however, giving too much play.

The crosshead should work only when the lever is thrown down, pressing the tightening pulley *C* upon the belt in such a way as to make it run either at full speed or with light blows. If this precaution is not observed, the crosshead will give counterblows, which will cause a loss of force and an irregular and jerky action.

This type of hammer possesses the following advantages: Simplicity of construction; operation by a belt which permits the use of any sort of motive power; the regulation of the blow in intensity and quickness for any given speed; the power of varying instantaneously the number and the force of the blows; the small amount of power required relatively to the effect produced; the form of the frame carrying the anvil-block in front, and thus leaving three faces of the anvil free; lastly, by its rapid and continuous blows, the forging is heated in place of being cooled while on the anvil.

The distance between the anvil and the hammer face at the end of its stroke should be about 55 mm.

The counter-blows, which should be especially avoided, will take place: 1. When the distance between the hammer and the anvil is too small. 2. When the belt is too loose and leaves too much play on the hammer-pulley; this will occur also when the distance between this pulley and the counter-shaft is too great.

These hammers should never be used for heavier work than that for which they are intended. It must be remembered that they are specially adapted to drawing out, rather than to die-work.

Their use is especially in the manufacture of arms, cutlery and for the heavier work of a coppersmith; that is, in all shops where there are many small forgings to be made.

The weight of the heaviest hammers of this type which have so far been constructed is 125 kilogrammes.

CHAPTER XL.

THE ARNS PNEUMATIC HAMMER.

This hammer, which is shown in figs. 125, 126, 127 and 128, is built by M. Beauduin, at Sedan, who holds a French patent covering the exclusive right for that country.

These hammers are built of a power varying from 6 to 100 kilogrammes. It is distinguished from other similar hammers by the simplicity of its construction; it works with a belt and can be run up to 250 blows per minute.

The alternating motion of the blow is obtained by a cast-iron piston furnished with small grooves, and having no segments. This piston moves in a cylinder solidly fixed to the frame, and is separated from the hammer by an open space, or compression chamber, which secures their joint action without interfering with their independence; this chamber forms a natural spring for the hammer. The hammer is thus drawn up by the vacuum created by the piston in its ascending stroke, while it is thrown back when the piston descends with the additional force obtained by the compression of the air.

The force of the blow is obtained by the working of a valve, which admits into the compression chamber a certain quantity of air, which is proportioned to the force of blow desired.

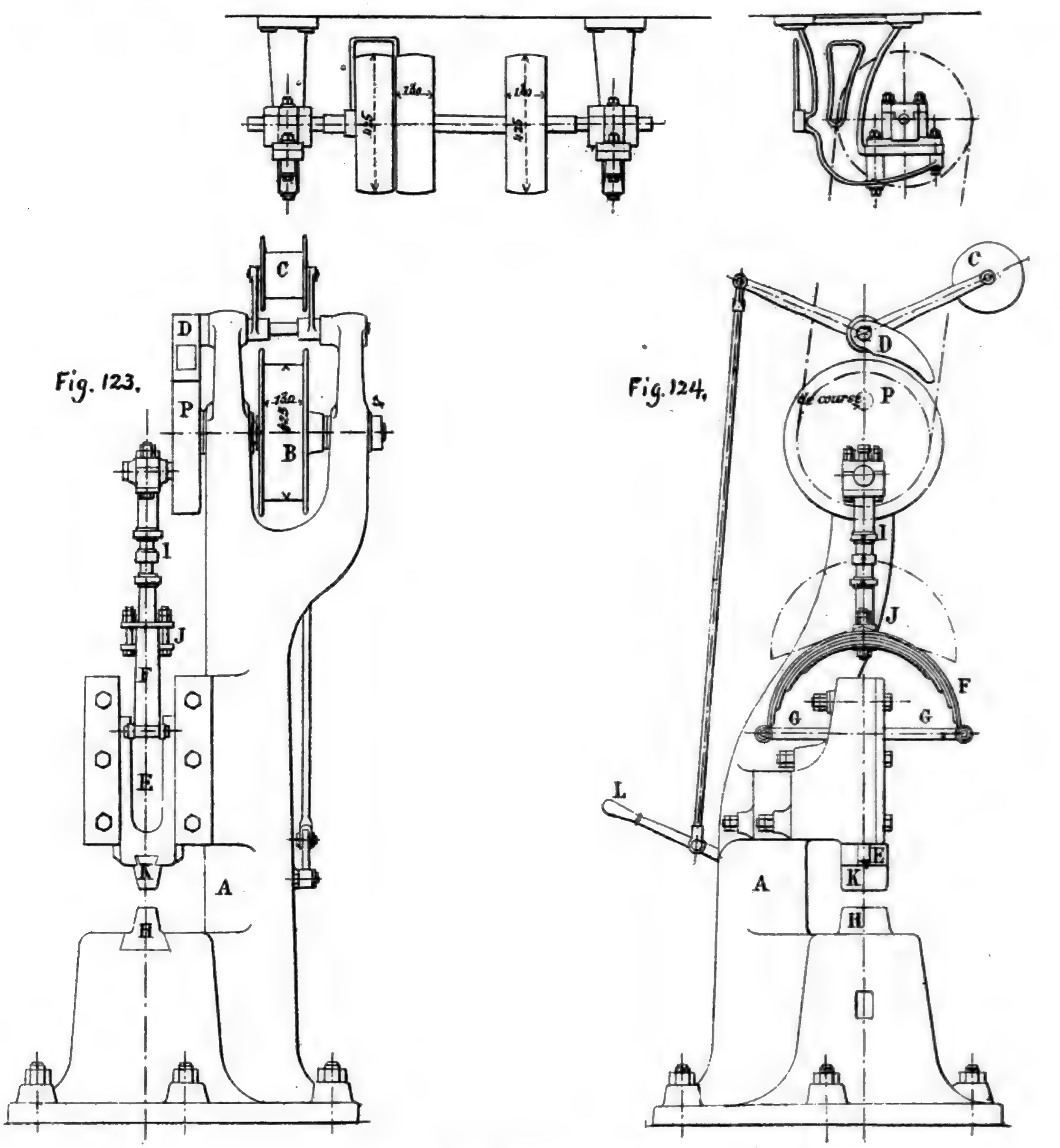
A brake, working with this valve, stops the hammer instantaneously at a certain height above the anvil, whatever may be the speed of the piston, and without the necessity of stopping the latter. If the valve is wide open, the brake holds the hammer in its position and the atmos-

pheric pressure no longer acts upon it; the opposite result is produced if the valve is closed, because the hammer, being drawn up by the piston, throws the brake back and acts freely again.

The piston having a large diameter can work even when the wear amounts to as much as 1 mm., because a comparatively imperfect vacuum is sufficient to raise the hammer.

The hammer itself is of cast-steel; it carries circular grooves and a longitudinal slot which prevent it from turning in the cylinder.

This hammer is to be recommended for its easy working, the energy of the blow which can be regulated at will, and the power of stopping its motion instantaneously without the use of a brake and the consequent wear. It is useful especially for forging and drawing out pieces of comparatively small thickness, its stroke being necessarily limited.



THE BOUHEY SPRING HAMMER.

CHAPTER XLI.

THE CHENOT ATMOSPHERIC HAMMER.

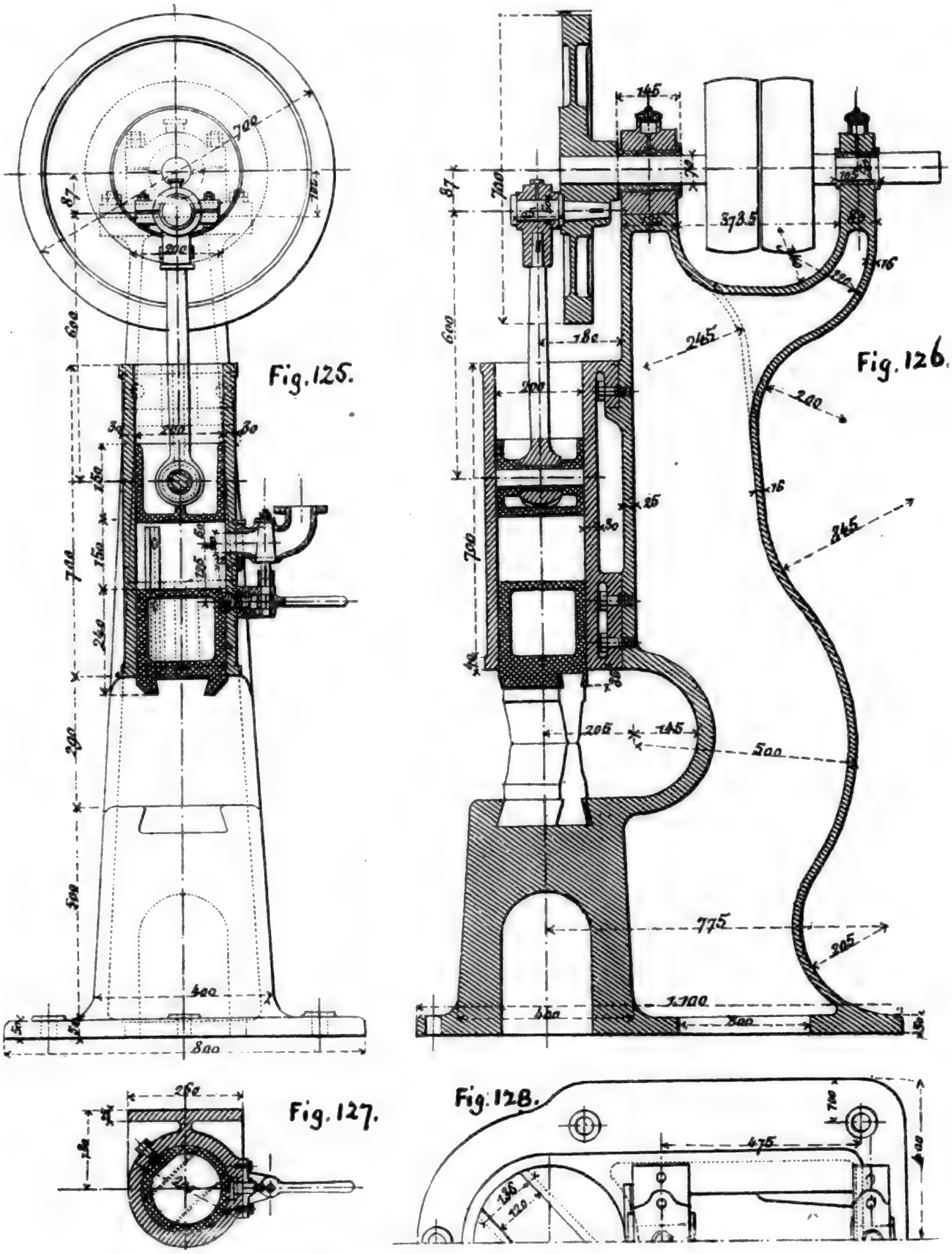
This hammer, which is shown in figs. 129, 130, 131, and 132, is an ingenious mechanical application of the principle of the perfect elasticity of the air. It is composed of a movable cylinder *C F*, which is made of forged steel of high resistance, able to support all the shocks of working. In this cylinder two pistons *P S* and *T I* work, their working being regulated by a connecting rod *D* driven by a crank-pin *M*, which is mounted on a face-plate *P V*. This face-plate is keyed to a shaft which carries at the other end a pulley, over which runs the belt giving motion to the tool.

The rotary motion transmitted by the belt to the hammer-shaft is thus transformed directly by the face-plate and crank into a reciprocating motion of the pistons, which are joined together by the rod *T*.

On the counter-shaft are placed three pulleys, the first connecting with the hammer-shaft ; a second fixed pulley carrying the driving belt from the main shaft, and a loose pulley upon which the belt can be thrown when we wish to stop the hammer.

The working of this tool is very simple. When at rest the face-plate P V is held by the brake f, but when the hammerman draws towards him the lever L, the brake is raised, and the tightening pulley T e, acting upon the belt the shaft A is then put in motion, and the stroke begins.

When the hammer touches the anvil, the lower piston P I, as it begins to rise, compresses the air in the chamber No. 2, and at a certain position of the crank-pin, the striking cylinder is set in motion on its ascending stroke by the action of the compressed air under the diaphragm D of the moving cylinder C F. The latter, once started, continues its ascending stroke, but during this time the crank-pin passes its upper dead-point and reverses the motion. At the same instant, as the diaphragm D and the upper piston P S are moving rapidly towards each other, they would strike together violently were it not for the existence of the upper cushion of air in chamber No. 1 ; the striking cylinder is thus stopped without shock and without losing its force, while the compressed air in the chamber No. 1 expands and thus restores to the cylinder all the work which was absorbed in the compression.



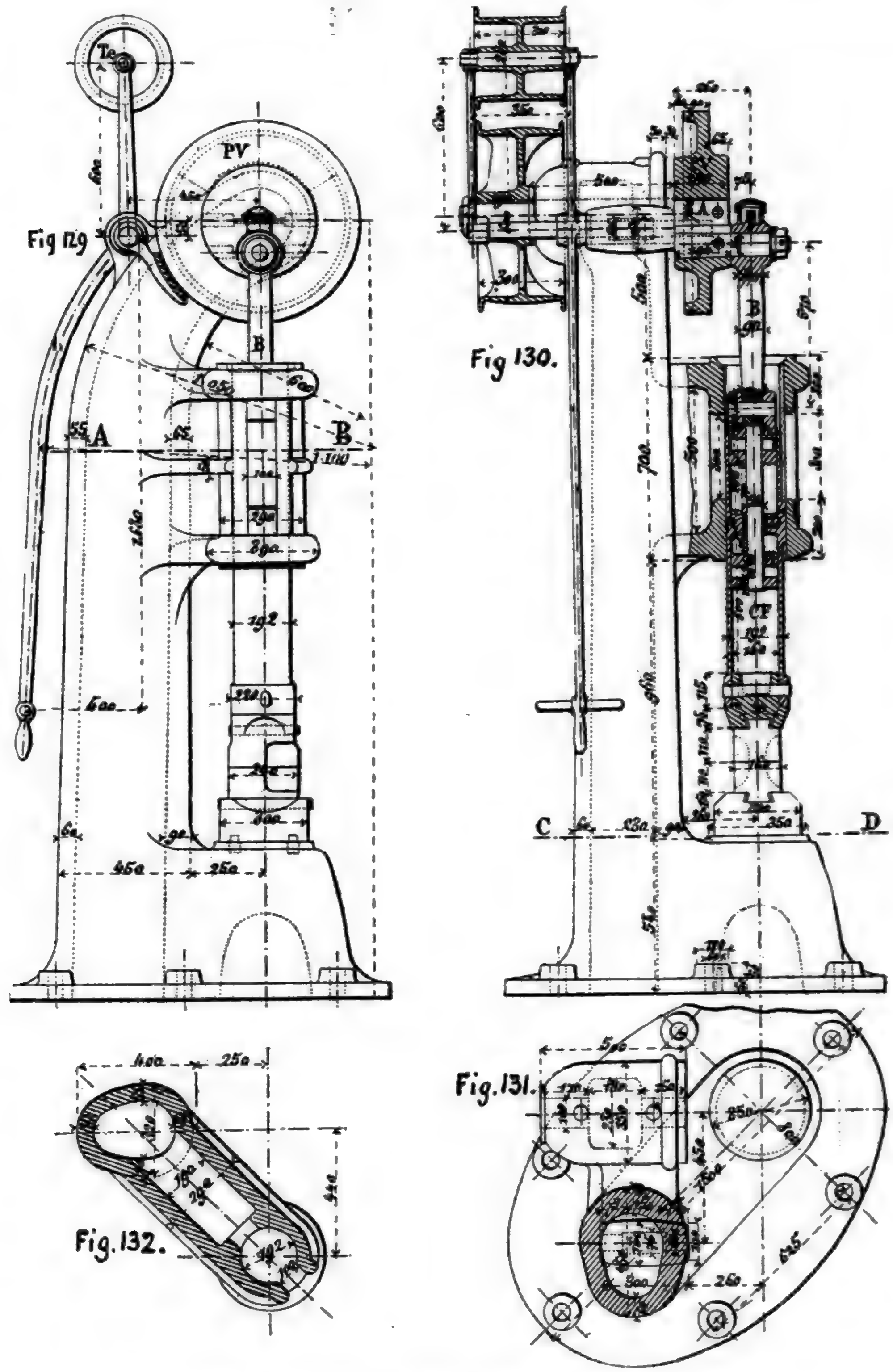
THE ARNS PNEUMATIC HAMMER.

By the expansion of the air the striking cylinder is thus thrown down upon the anvil, producing a blow which will vary in intensity according to the speed of the shaft A.

The forging is perfectly free under the hammer, since the latter rebounds immediately when the blow is given. The forging can, therefore, vary very much in form and thickness without inconvenience, since the hammer adjusts itself to any variation in thickness.

of a double-acting steam-hammer, with this difference, that the movement is given by a belt and that there may be secured in this way a considerable economy in power.

Speaking generally, these hammers when in good order and properly lubricated will utilize about 70 per cent. of



THE CHENOT ATMOSPHERIC HAMMER.

By means of the lever *L*, which works the tightening pulley, and the brake, we obtain either the instantaneous stoppage of the hammer, or any desirable degree of speed with the greatest facility.

In this system of hammer the striking cylinder is only a secondary factor in determining the intensity of the blow. The chief factor is the pressure of the air, and this pressure may run up to four or five atmospheres, this resulting from the natural play of the moving parts.

The action of this hammer is therefore similar to that

the power employed. They are especially used for forging, drawing out, and die-work.

The heaviest hammer yet made of this type is of 750 kilos. M. Chenot also makes a hammer working with air and steam mixed, the steam being admitted under a piston, the rod of which is extended and carries the striking cylinder, and can thus compress the air contained in it. In one of these hammers there have been measured by a pressure gauge pressures of 5 atmospheres in the steam cylinder and 7½ atmospheres in the air cylinder, although the

section of the latter was greater. This effect was due to the inertia of the striking mass taken up by the air spring.

This last type, although more complicated than the simple atmospheric hammer and of a somewhat delicate construction, may be extremely useful in many shops.

CHAPTER XLII.

THE ROBSON & PINKNEY PATENT GAS HAMMER.

This hammer, which is manufactured by the firm of Tangye Brothers, in Birmingham, England, is shown in figs. 133, 134, 135, and 136; fig. 133 being a perspective view; fig. 134 an elevation, with the upper part in section; fig. 135 a front view, and fig. 136 a perspective view of a hammer worked by a foot-lever instead of the hand-lever used in the smaller type.

In this hammer the cylinder *C* contains two pistons, one of which is used to fill the cylinder with the explosive chamber. The motion of the hand-lever *X* is limited by the stop *S*. The charging piston in its upward movement expels all gases above it by means of the exhaust passage *R*, until, when its highest position is reached, this part is covered by the piston. The same movement draws in between the pistons the mixture of gas and air ready for an explosion, and at the proper time a roller on the rod *L* lifts the igniter bolt, uncovering a Bunsen flame, and firing the charge.

The force of the explosion and the continued expansion of the gases drives the piston *D* downward until the blow is delivered.

The force of the explosion does not come against the charging piston *A*, because in it there are two valves *I I* opening upwards, which allow the gases to pass through them, thus equalizing the pressure upon both sides of the piston.

Fig. 133.

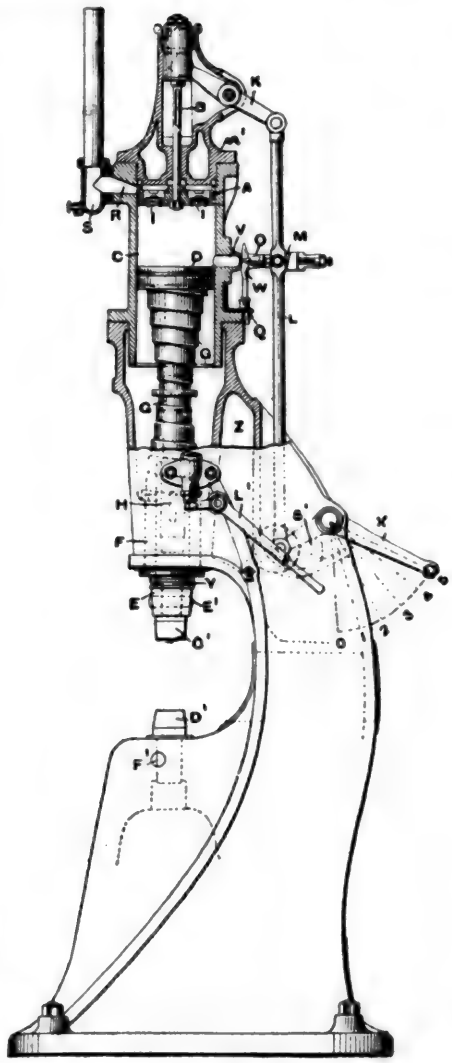


Fig. 134.

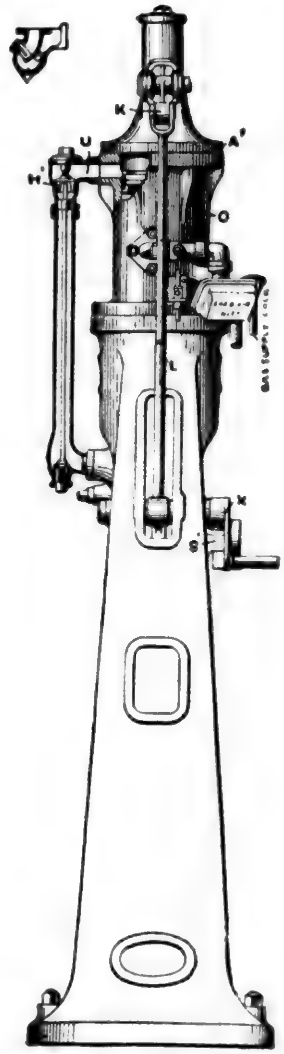


Fig. 135.

THE ROBSON & PINKNEY GAS HAMMER.

mixture, while the other transmits the shock of the explosion to the hammer. The hammer rises again under the impulse given by the volute spring, and to prevent it from striking against the guides *F* a spiral spring is provided which checks the upward movement.

Examining figure 134, it will be seen that the charging piston is shown at the upper end of its stroke, a position which corresponds in working to the admission of the explosive mixture between the two pistons. This piston has two automatic valves *I I* opening from below. The piston rod *B* is guided by the stuffing-box, and is enlarged above to receive the end of the rocking-lever *K*, which is connected by the rod and crank to the hand-lever *X*. By working the latter a charging piston *A*, and the working piston *D*, are brought almost into contact, and leaving between them only a small space forming the explosion

After the delivery of the blow, the charging piston is forced down by the lever *X*, and as soon as it has descended far enough to uncover the exhaust port *R*, the gases escape through the valves *I I* and the exhaust port *R*, until the pressure is reduced to that of the atmosphere. The same movement allows the igniter bolt to shut off communication with the flame.

A soon as the pressure is sufficiently reduced, the volute springs *G* raise the piston *D* and the hammer to the position shown; this upward movement being arrested by buffer springs and leather collars at *Y*. Now, the downward motion of the charging piston being continued until it is near the piston *D*, it is again raised to the position shown, and another blow delivered. This may be repeated 120 times per minute if it is desired to obtain blows of maximum force.

Now, it is evident that the charging piston, with its valves *I I*, is identically the same in its action as the plunger of an ordinary lifting pump, and that if it is brought down by the movement of the lever *X* quite close to the piston *D*, and then raised to its highest point, the space between the pistons will be filled with the explosive mixture; but if it be made to descend only part way and then raised, only as much of the explosive will be drawn in as is equal in volume to the displacement of this shorter stroke, and the force of the blow is therefore proportionally reduced.

Thus, for producing light blows the hand-lever *X* is always raised to position 5, but is depressed to position 4, 3, or 2, according to the force of the blow which it is desired to deliver, precisely like the hand-lever commonly

Fig. 136.

used in steam-hammers for controlling the slide valve; the similar movement produces precisely similar results, and the effort required to move it is no greater.

In cases where it is desired to strike very light blows, a relief valve is provided, which allows part of the pressure to escape; this valve is operated by the lever *L* in the hand machine, or in the treadle machine (fig. 136), it may be operated at will by the same motion of the foot which works the hammer. This is accomplished by fixing the plates for the foot at the ends of a crossbar which is swivelled to the lever in such a way that it may be swung around by the foot, so that in its descent it comes in contact with the relief valve lever.

The use of this gas hammer, as it has been described, requires two men, but by employing the foot-lever shown in fig. 136 the hammerman can control the operation alone. This works in very much the same way as the hand lever, but the working is, more naturally, very slow.

The result of experiments made by Mr. Dugald Clerck with an improved Richards indicator, shows that the maximum pressure actually exerted by the gas was 57 lbs. per square inch. At the commencement of the working of the hammer, which had been at rest for a considerable time, this maximum pressure was obtained for four-tenths of the stroke of the piston. It is estimated that a skilled workman using this hammer can run it up to about 120 blows per minute.

(TO BE CONTINUED.)

CABLE TOWING IN FRANCE.

For a number of years past experiments have been made in France, under the direction of the Government, with various plans for cable towing, or for the substitution of some form of steam-power for horses in hauling boats on the canals. These experiments have not heretofore been attended with very much success, but the latest and most promising of them has been conducted by M. Maurice Levy, who was placed in charge of the matter some time ago. The arrangement which he has made is described in a recent number of the *Portefeuille Économique des Machines*. The trial was made at Gravelle, where the St. Maurice Canal joins the St. Maur Canal at right angles, this point being chosen in order to give the system the severest possible test. The cable extends a distance of about 650 meters, covering the section between two locks. The steam-engine which operates the cable is placed near one of the locks, and the cable itself runs along one bank of the canal, returning upon the other.

The motor used in this case was a portable engine of 15 H.P., but it has usually not been called upon to furnish

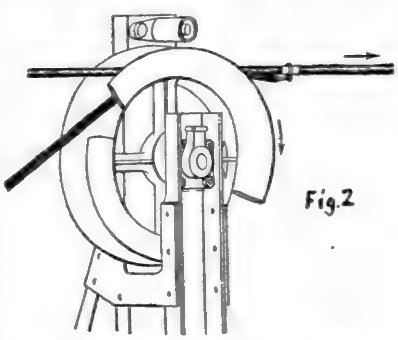


Fig. 2

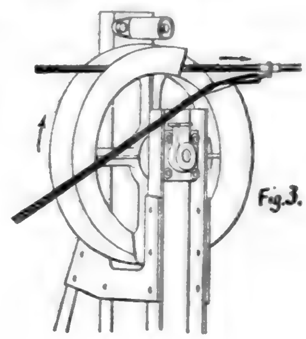


Fig. 3.

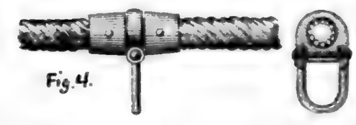


Fig. 4.

more than 10 H.P. This engine runs by a belt a driving shaft upon which is a pinion, and this pinion engages with a large spur-wheel making about 10 revolutions per minute and carrying on the shaft with it the main driving-wheel of the cable. This driving-wheel is 2 meters (6.56 ft.) in diameter, of iron lagged with wood. The cable passes over two grooved wheels which hold it in place and direct it upon the driving-pulley. The tension-pulley, which is also 2 meters in diameter, is mounted on a car, which runs upon a track 7 meters (23 ft.) in length, and which is connected by a heavy chain with a weight of 7 tons, suspended in a vertical well. The whole arrangement will be readily understood from the diagram in fig. 1, in which the center wheel of the three shown together is the driving-pulley, while the wheel mounted horizontally upon an upright is used to direct the cable to the opposite bank of the canal.

The supporting pulleys over which the cable runs are mounted on upright posts 3 meters (9.84 ft.) above the surface of the tow-path, they are 0.600 meter (2 ft.) in diameter, and the groove in them varies in width from 0.200 meter at the top to 0.120 at the bottom. This groove is slotted at the side in order to permit the passage of the tow-rop. The arrangement of the pulley and the method in which this tow-rope passes upon them with the cable, and is then disengaged, is very plainly shown by figs. 2 and 3. Fig. 4 is an enlarged view and section of the clamp and eye by which the tow-rope is fastened to the driving cable. These clamps can, of course, be put on at such intervals as may be considered desirable.

In this case special arrangements were necessary in order to overcome the right angle at the junction of the two canals. At this point it was necessary to use four large pulleys, two on each bank of the canal. There are very few cases, however, where a canal makes a bend at right angles, and for ordinary curves it is usually necessary only to employ the same pulleys for carrying the cable that are used at other points, simply giving them an inclination to the horizontal greater or less, according to the sharpness of the curve.

The method of attaching the boat to the cable is shown in fig. 5, which is an outline sketch. It will be seen that the towing-rope is attached to one of the eyes clamped on the cable; this towing rope is about 20 meters (66 ft.) in length and carries at its end an eye to which can be hooked, or otherwise fastened, the end of the rope attached to the boat. The method preferred is to attach this to the rear end of the boat, connecting it to the forward end by passing it through an eye reeved into the end of a short rope fastened to a post. A short cord attached to the eye of the towing-rope is provided by which it can be drawn down to the boat when the boatman wishes to attach or to detach it.

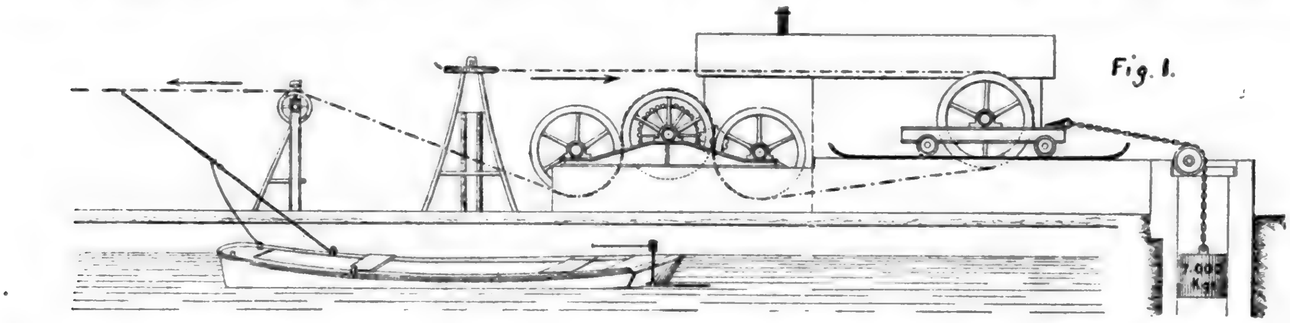


Fig. 1.

The main rope used in this case was a steel wire cable 31 mm. (1 in.) in diameter, while the towing ropes are ordinary hemp rope. The main cable has a section of 316 sq. mm. and weighs 2.800 kg. per meter (5 65 lbs. per yard).

The boats on this canal, which are chiefly used to transport coal, sand, and building stone, carry a load varying from 150 to 200 tons. The cable is run at a speed of 3½ kilos. an hour, which is nearly the speed of the usual towing by horse-power.

From a study made by M. Levy, and from the calculations based upon his experiments, he has arrived at certain conclusions as to the best method to be adopted in the use of this form of cable. The length of the sections will, of course, depend largely upon the position of the locks; but where there is a clear stretch the motive power stations should be placed about 20 kilom. (12½ miles) apart, and each machine would then run two cables, each

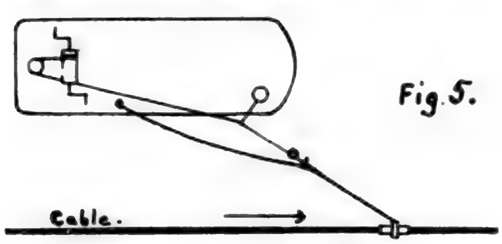


Fig. 5.

one covering a distance of 10 kilos. This length of section, M. Levy thinks, would be found most convenient usually, would not require the use of very large motors, would enable the engineers to use steam or water power, and would permit all the arrangements to be adapted to local circumstances.

The speed adopted should be the same, or a little greater, than that usually employed in horse towing, that is, about 3½ kilos. (2.18 miles) an hour. As on the French canals it generally takes about 20 minutes to pass a boat through a lock, the towing-rope attachments would be placed on the cable, running at the speed given, about 1,200 meters (4,000 ft.) apart, and there would then be about 16 boats on each cable at a time, provided the canal was fully employed, which would, of course, not always be the case. With 16 boats, all loaded, the tractive effort is estimated at 7 tons, and the engines at each station would have to be of about 150 H.P., in order to provide a sufficient reserve of power.

M. Levy, after having analyzed the irregular movement of traffic on small or branch canals, believes that the only method of providing for this consists in giving the cable a considerable tension, calculated in such a way as to keep any oscillations or irregularities of motion within narrow limits.

These experiments have been so far successful that it is proposed to make other applications of the system on the French canals, and it is probable that before long this will be done on several large sections where there is a heavy traffic. It is understood, that in order to make the cable towing profitable and to prevent any interference, the use of horses will be forbidden upon all sections where the cable is placed and all boats will be obliged to use the cable.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer.*)

(*Continued from page 122.*)

X.—THE POULET SWITCH-LOCK.

To avoid the complications of the Dujour system and of other systems which we have described, M. Poulet has revived the principle of an arrangement formerly tried in England for working switches, and has applied it, at the same time modifying it so that the locking and the movement of the switch-rails is made by a single movement of the lever.

This arrangement, which is shown in fig. 56, is in use at a number of stations on the Northern Railroad of France.

By means of the lever B the single connecting-rod T works on one side the stop P, and on the other the bar t of the lock. To t is fixed the bent rod $k\ l\ m$, which, in its normal position, enters a slot in the connecting bar or plate E of the switch.

In the first part of its stroke the end m of the lock is drawn back and unlocks the bar; in the second part the inclined plane k acts upon the slot, forcing the bar from its former position and giving it the necessary movement to change the switch, while in the third part the switch is locked in its changed position.

It will be seen that this system has the advantage of locking the switch by acting on the connecting-bar directly, instead of working outside of the track. Moreover, it has an easier movement than the other systems, especially if the angles of the inclined plane of the locking bar are rounded; the motion is then transmitted with very slight resistance, and there is none of that opposition which usually forces the signalman to make a considerable exertion in moving the lever. The gain—less time taken and less fatigue to the operator—is very noticeable in a busy signal-post.

XI.—THE HENNING CAM-LOCK.

In some stations on the Swiss and the Swabian railroads M. Henning has applied a switch-lock worked by a cam, which differs from most of the systems in use in having the switch-rails independent and coupled to the locking

apparatus by distinct connecting-rods. This apparatus is shown in figs. 57, 58, and 59.

In these illustrations *A* and *C* are the two rails of a switch set, for example, for the right-hand track. The switch-rail *A* is joined by the bar a^1 *a* to the bell-crank or

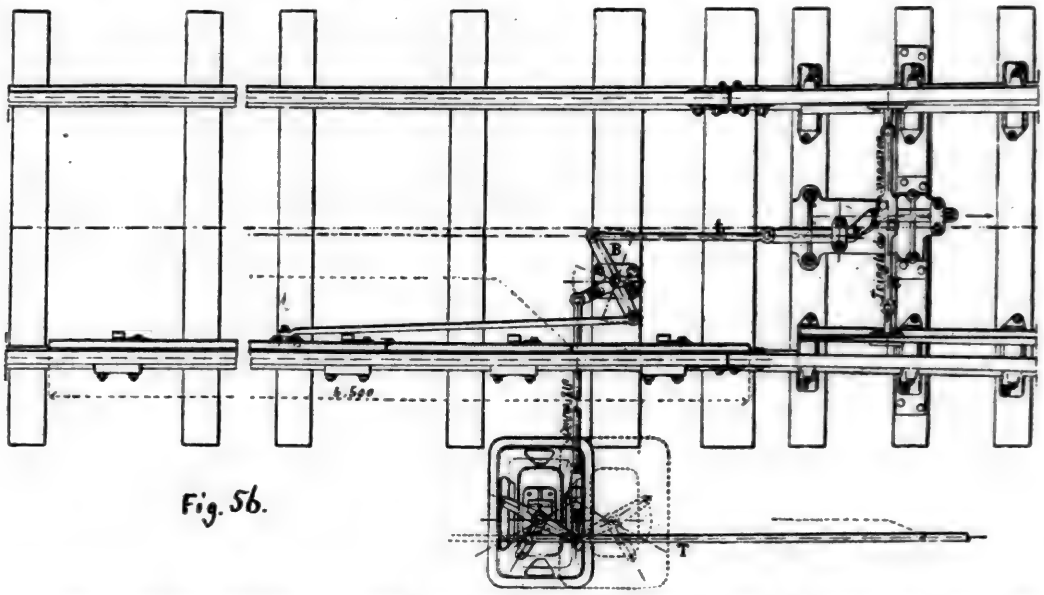


Fig. 56.

bent lever *a b c d*, and is pressed against the main rail by the lug *a* on the plate *f*; the switch-rail *C* is connected with the same lever by the rod c^1 *c*. In working the switch the lever *a b c d* takes the position shown in fig. 59; the

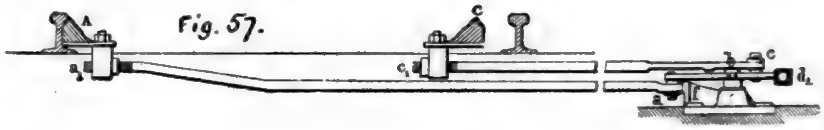


Fig. 57.

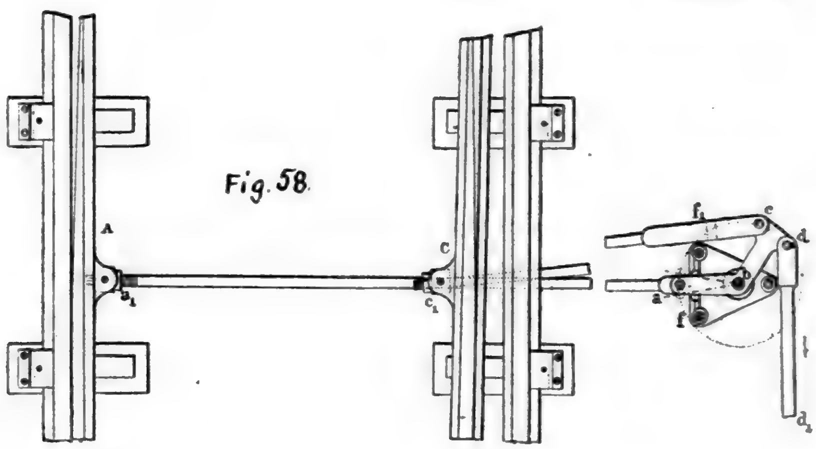


Fig. 58.

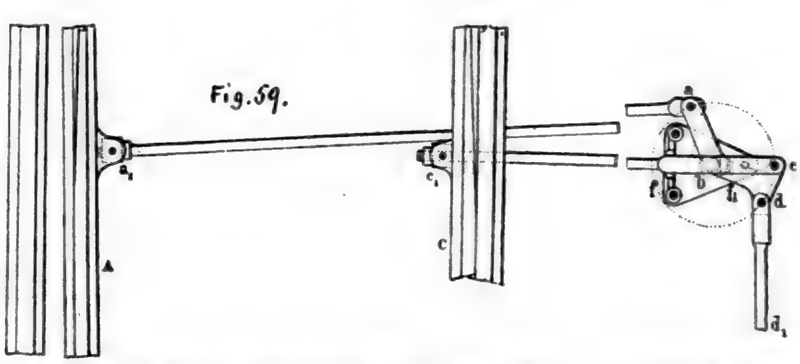


Fig. 59.

switch-rail *A* is no longer held, but is drawn away from the rail, while the position of the switch-rail *C* is secured by the pressure of the lug f^1 against the pin *b*.

This apparatus is regulated for an average temperature, and the points *a* a^1 and *b* or *c* c^1 and *b* are then in a straight line; when the length of the connecting-rod *d* d^1 varies under the influence of a change of temperature, *a* or *c* will depart a little from their mean positions, but the lugs *f* and f^1 will always remain in contact with *a* and *b* in such a way that the position of the switch-rails is always secured.

When the switch is moved automatically—that is, by a wheel passing over it from the heel—the switch-rail *C* moves first, and the lever *a b c* turns without offering resistance. In order to prevent any risk of breaking the connecting-rod *d* d^1 the slot in which the spring-lock of the working lever catches is beveled, so that the lever can work automatically.

This system has its special application to switches at stations and in yards which are not preceded or covered by signals, but where it is, nevertheless, desirable to place the switches under the control of a single operator in a central post or station.

XII.—THE SERVETTAZ CAM-LOCK.

THE object of this apparatus, which has been placed in the central signal-house of the station at Savone, on the Mediterranean Railroad in Italy, is to obtain :

1. With a primary transmission, but with two distinct levers, the movement of the switch and the blocking of the switch-rails by means of cams.

2. With a second transmission the return locking of the lock-lever, in such a way that it will be impossible to move it, and to free the other apparatus interlocked with it, if the switch-rails are not at the end of their course and properly wedged.

An apparatus of this kind, working electrically both for the movement of the switch-rails themselves and for the control of the return movement, is on trial on the Northern Railroad of France.

As will be seen, this system differs from all those of which we have spoken by this new idea of using the movement of the locking apparatus to control a return movement of the lever. It is clear that in this way we escape the inconveniences resulting from the simultaneous breaking of two connections, which is always possible, though not very probable; the signalman would be at once warned, because in that case he would find it impossible to move the switch-lever. This fertile idea has many applications, and can be carried into practice even when we replace mechanical connections by hydraulic or electric transmission. In these cases the principle of return locking continues in force, and its advantages are still more marked, since it gives means of controlling safely a movement made by the aid of forces of which some engineers are still doubtful.

The points to be examined in the Servettaz system are : The working apparatus, the wedging cams, and the apparatus for return locking.

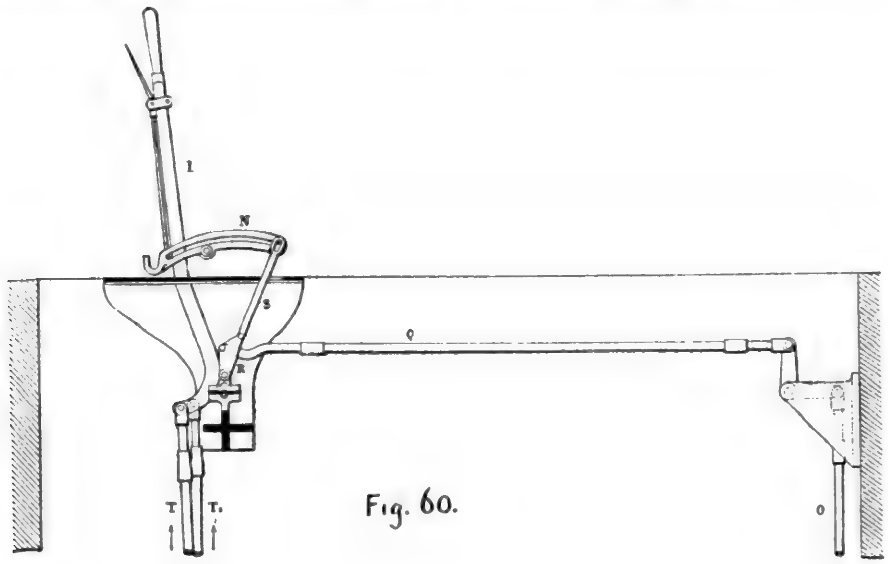


Fig. 60.

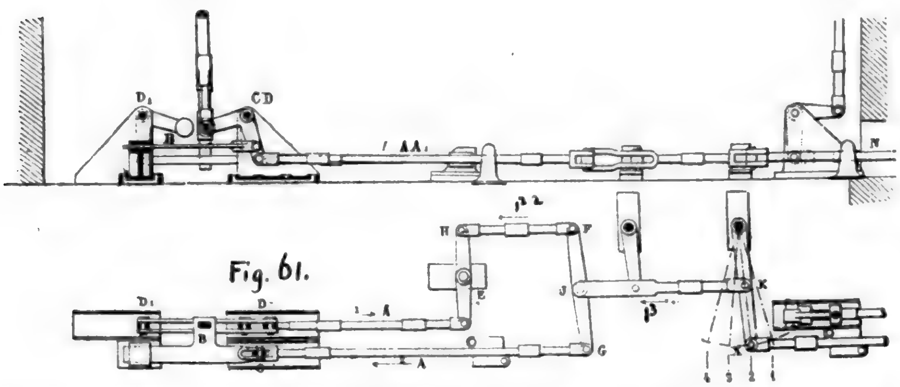


Fig. 61.

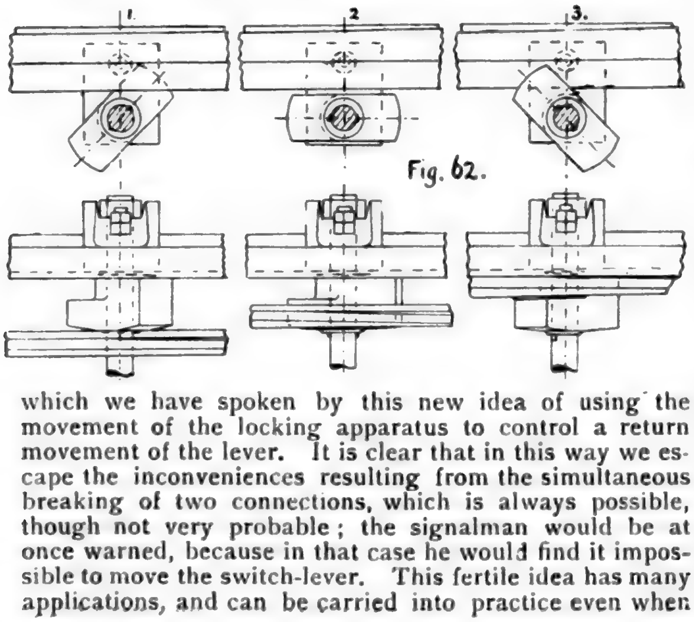


Fig. 62.

The working apparatus, shown in figs. 60 and 61, consists of two levers, one corresponding to the switch, the other to the lock, and both acting on a single connection through the use of an arrangement similar to that described in the Saxby & Farmer double-acting lock.

These two levers *L* command, when they are reversed in the direction of the arrow, the movement of the bars *T* T^1; that of the switch-lever acts through the bell-crank *C* on the bar *A*, and carries also a plate *B*, which serves to connect the bar of the locking lever with the plate *D* or with D^1, in such a way as to move the bar *A*, either in one direction or the other, according to the position of the switch-rails.

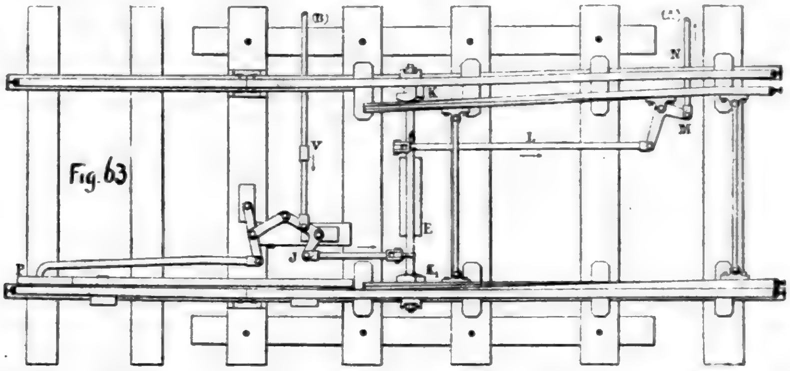
This being placed, the switch being normally locked, the signalman commences by reversing the locking lever in order to free the switch-rails, so that they can be worked. In this movement the bar T^1, which is united to the plate *D*, displaces the bar *A* in the direction 1, and through the locking-lever *H*, the connecting-rod moves the connecting-rod *H F* in the direction 1^2; *G* being fixed, since the switch-lever is immovable, the connecting-rod *J K* moves in the direction 1^3 in such a way that the point *X*, which is the point of attachment of the connection which changes the switch, passes from the position 1 to the position 2, the effect of which, as we will see, is to free the switch-rails.

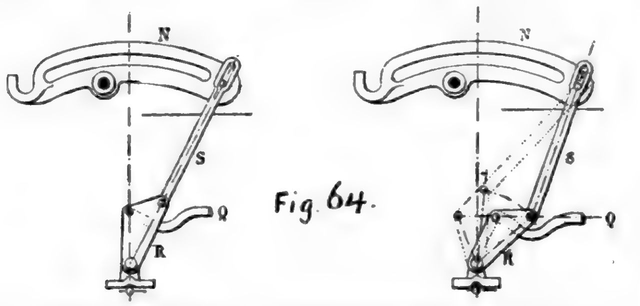
The signalman can then reverse the switch-lever, which has the effect, through the plate *C*, of moving the rod *A* in the direction 2 ; as the locking-lever is immovable, the point *F* is fixed, and this movement is transmitted through the connecting-rod *J K* to the point *X*, which passes from the position 2 to 3, in such a way that the switch-rails give an opposite direction to that which they

before had. At the same time the plate B causes the rod T^1, of the locking-lever to pass from the plate D^1 to the plate D.

Finally, to lock the switch-rails in their new position, the signalman returns the locking-lever to its original position; the rod T^1, acting on the square D, causes the connecting-rod to move in the direction 1, and consequently brings K into the position 4, in such a way as to lock the switch-rails in their new position.

Thus, through this combination of levers and the Saxby plates, M. Servettaz reaches the result that a movement and a return movement of the locking-lever, and a reversing movement of the switch-lever are transformed into a movement in one direction of the connection between the signal cabin and the apparatus. It remains to be shown how, by the aid of this continuous transmission, the unlocking, the movement, and the relocking of the switch-rails are effected.





Instead of a lock or bolt entering the switch-rails, M. Servettaz has used a double cam, interposed on one side between one of the switch-rails and the main rail, and on the other hand forcing the other switch-rail to bear against the main rail.

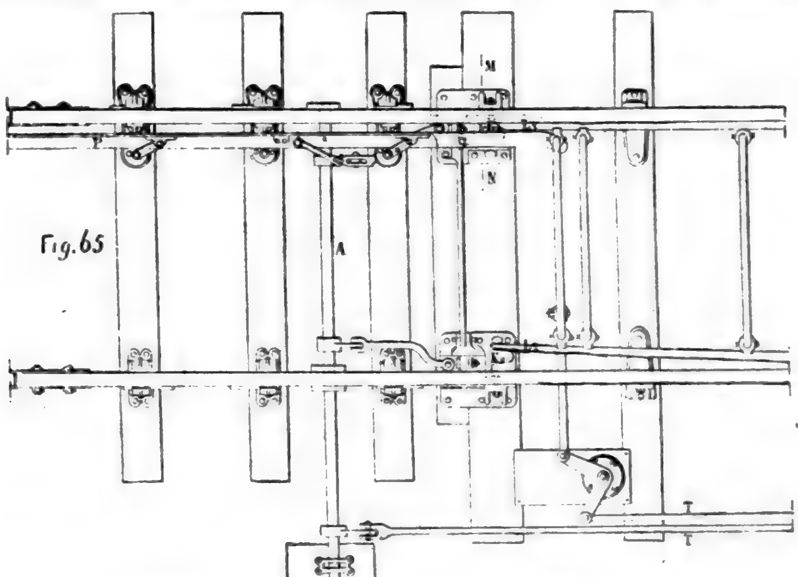
Fig. 62 shows the arrangement of the cam and the position it occupies for one of the switch-rails at the close of the three stages of working which we have described.

Fig. 63 is a plan giving the position of the two cams in relation to a change of the switch, the manner in which they are moved by a single connection V, which works also a safety or guard-rail P of the ordinary type. This connection V is moved in the direction shown by the arrow, and through the bell-crank J causes the lock E to turn.

During the first part of the movement, the cam K—in the position 1, fig. 62—opposes its entire thickness to the movement of the switch-rail, but turns gradually, and, owing to its peculiar form, permits the switch-rail to move; the other cam K^1, as shown on the plan, is inclined in such a way as to force the corresponding switch-rail against the main rail, while the other cam K^1, set at an angle of 90° with K, is entirely interposed between the corresponding rail and the main rail; each switch-rail is then securely wedged fast.

Independently of this double wedging, the apparatus has this great advantage over locks with a single connection, that while the movement of the levers is subdivided into three definite stages, the movement of the switch-rails proceeds steadily by the action of the cams, the form of which has been carefully studied out in such a way as to solve this mechanical problem. The apparatus, therefore, does not present the resistance or the jerking movement which is found with locks having three separate movements.

On the bearing E, fig. 63, there is mounted a lever L which commands through the bell-crank M a special connecting-rod N, through which the return movement from the change of the switch passes through the signal cabin.



The movement of L displaces N in the direction shown by the arrow.

If, now, we refer to fig. 60, it will be seen that the displacement of this connection N is communicated to the rods O Q, the last of which works the sector R, connected to a rod S furnished with a slot, in which plays a pin fixed at the end of the link N of the lever L. Thus, account is given of the different positions, as shown in fig. 64; the sector R is laid down in such a way that the position of the point of attachment of the rod Q and of the rod S will coincide for each position of the locking-lever and of the connection N, fig. 60, and it thus results that the locking-

lever can be moved after the switch-lever has been moved, only if the position of the sector permits it ; that is to say, if the connection N has been moved from its normal position ; in other words, if the cams have properly wedged fast the switch-rails. In the opposite case, the connecting-rod N, which follows the movement of the cams, will not complete its course, and it will be impossible to reverse the locking-lever in the cabin, in such a way that, not only is the signalman warned, but he will also be unable to move the signals which would authorize the movement of a train over a half-open switch ; this is what would happen should the connection between the cabin and the switch be broken.

It can, then, be said that this apparatus gives a control over the working of the levers which secures all desirable safety without being more expensive than the double transmission type of switch-locks.

XIII.—THE HARRISON SWITCH-LOCK.

Under a similar heading to the apparatus just described will come the system of locking, or rather of wedging, the switch-rails, which has been used on the Northeastern Railroad, in England, by Mr. Harrison, Chief Engineer of that line.

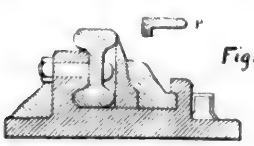


Fig. 66.

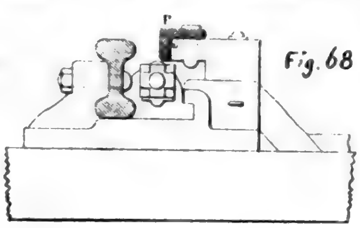


Fig. 68

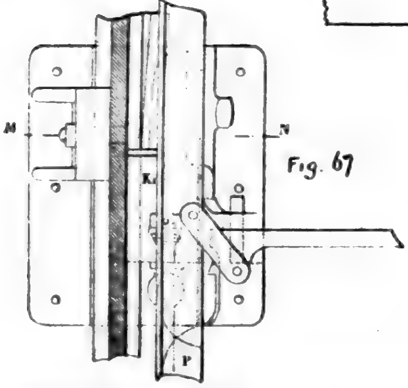


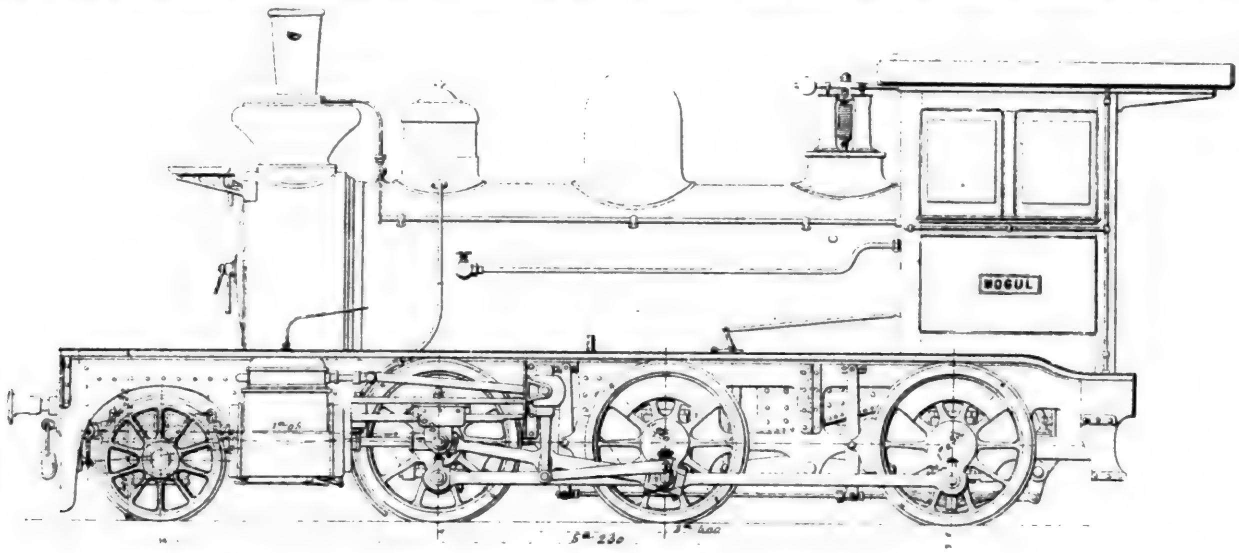
Fig. 67

As will be seen from figs. 65, 66, 67, and 68, the connection T^1, which produces this locking, is independent of the connection T which works the switch-rails $L^1 L^2$, in order to change the track ; the rod T^1 rotates a horizontal shaft A, to which are attached cranks, which, according to the direction in which the shaft A moves, cause the cams $K^1 K^2$ to enter between the switch-rails and the main rail, or withdraw from them.

These cams, $K^1 K^2$, are shaped in such a way as to fit exactly between the switch-rail and the main rail, or to wedge them together according to their position. In this way we obtain the absolute wedging fast of each of the switch-rails in any position of the switch. This arrangement, securing an entirely distinct locking, has given M. Bianchi, Engineer of the Mediterranean Railroad, in Italy, the idea of employing the cams which we have described in the Servettaz system.

As to the guard P, which is intended to prevent the wheel of a carriage from being thrown out of place while passing over the switch, instead of being moved vertically, like the Saxby guard, it is moved horizontally by the action of the back-and-forth movement of the bar G, which unites the two cams. While there is a bearing against the rail the displacement of this guard is impossible, and it follows that the switch cannot be unlocked.

(TO BE CONTINUED.)



MOGUL LOCOMOTIVE, NORWEGIAN STATE RAILROADS.

A NORWEGIAN LOCOMOTIVE.

THE accompanying illustrations from the *Revue Generale des Chemins de Fer* show a narrow-gauge locomotive for the Norwegian State railroads. It is of the mogul type, having three pairs of driving-wheels and a two-wheeled truck, and the design strongly resembles that of an American engine of the same type, the only important difference being in the use of the plate-frame, instead of our bar-frame, which must be considered an improvement, especially in a narrow-gauge locomotive. The truck is of the Adamssen type, which is in use on the Swedish State railroads, and which differs somewhat in its details from the ordinary Bissell truck. The gauge is 1 meter (3.28 ft.)

The smoke-stack is more peculiar in appearance than in reality to our eyes, the only real difference from an American one being that the cone and netting are placed at the base of the stack, instead of near its top. The construction of the stack is the same as that employed on the Swedish State railroads, which was illustrated in the JOURNAL for May, 1888, the cut being reproduced herewith.

The general dimensions of this locomotive are as follows :

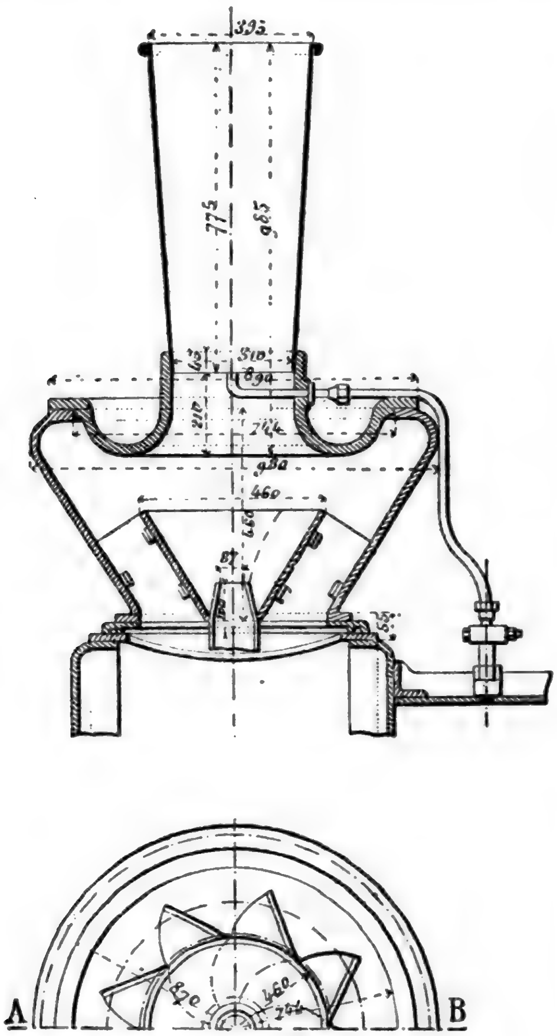
Diameter of cylinders......	0.350 meter	(13.78 in.)
Stroke of cylinders.........	0.460 "	(18.11 in.)
Diameter of driving-wheels..	1.050 "	(41.34 in.)
Fixed wheel-base........	3.400 "	(11 ft. 1.85 in.)
Total wheel-base..........	5.230 "	(17 ft. 1.91 in.)
Grate surface..............	0.94 sq. met.	(10.11 sq. ft.)
Total heating-surface.......	56.50 " "	(607.85 sq. ft.)
Usual working pressure of steam carried........		150 lbs.

The total weight of this locomotive in working order is

22 tons ; the weight on the driving-wheels is 18½ tons ; the tank has a capacity of 880 gallons, and about 2½ tons of coal can be carried.

The *Revue* makes the following general remarks on the rolling stock of the Norwegian railroads : " Whoever has traveled in the northern part of the United States will be struck in passing over the Norwegian railroads with the marked resemblance which exists between the general appearance of the system, the methods of construction, of track, and of rolling stock to the corresponding types in America.

" The narrow-gauge lines especially run through districts which, by their picturesque appearance and their



SMOKE-STACK, NORWEGIAN RAILROADS.

general configuration, recall vividly the appearance of many districts in the Northern United States. The traffic in lumber and logs, for instance, is carried on in these districts under very similar conditions and has much importance.

" It is impossible to resist the conclusion that the engineers who have laid out the Norwegian lines, and especially the narrow-gauge lines, have received their education in America, and have drawn from that country the principal elements of their technical methods. In both countries the bridges crossing the rapid and variable streams are built with the same daring originality of design and on similar plans. The locomotives almost all resemble very strongly American types of corresponding power. As to the cars, if in Norway all the details of general use in United States have not been adopted, it has been because the traffic at the time when the railroads were built was not sufficiently large to justify the use of such heavy rolling stock ; but as business increases there is a constant tendency to approach more and more to the principles of construction employed in the United States.

" Among other examples of construction on these roads there is especially to be commended a postal car of very convenient design, which is carried on two trucks after the American fashion, and presents the advantage of easy running and of much greater stability than the postal cars ordinarily in use on the European railroads."

MODERN WAR-SHIPS.

THE following passages contrasting the modern war-ship with that of a century ago, and giving an outline of the classification of a modern navy, are taken from a very interesting paper read before the United States Naval Institute at Annapolis, by Lieutenant J. F. Meigs, U.S.N., and published in the *Proceedings* of the Institute.

TWO TYPICAL SHIPS.

A consideration of the changes in tactical features between the *Constitution*, built in 1797, and the *Atlanta*, built in 1883—a century apart nearly—is very striking. The table below gives the batteries of the two ships, the one given for the *Constitution* being that carried when she fought the *Guerrière*.

	Constitution.	*Atlanta.*
Guns carried.............	32 long 24s. 22 short 32s.	6 6-in. B. L. R. 2 8-in. "
	—	—
Number of guns..........	54	8
Weight of broadside... ..	684 pounds.	800 pounds.

With her long 24s, the *Constitution* could probably just about penetrate her own side—some 20 in. of oak—at 1,000 yards range ; to penetrate with the short 32s, she would have to approach nearer. This ship, then, is completely protected against her own fire at ranges greater than 1,000 yards ; she is impenetrable to it at greater range, and this extends, it should be noted, to the ship's life—her buoyancy and stability—and to the lives of her crew. The *Atlanta's* 6-in. guns can penetrate at 1,000 yards, about 11 in. of iron—that is, a thickness 22 times that of her side at the water line ; and the 8-in. guns, at the same range, can penetrate about 14 in. of iron. And, it may be observed, the ½-in. steel of the *Atlanta* has just about the same resisting power as the 20-in. oak of the *Constitution*. Thus, while the defensive power of the hulls alone is the same, the later ship has a battery which has gained penetrative power in about the ratio of 25 : 1. Nor will the balance be materially altered by including in the discussion the other defensive arrangements of the *Atlanta*. Her under-water protective deck may throw off a 6-in. projectile fired at 1,000 yards range, but it hardly would an 8-in. ; and, so far as the protection afforded the gun's crews by the shields goes, there is nothing gained, as these are intended only to keep out quick-fire projectiles. If we examine the danger of raking fire to the two ships, the showing of the protection of the *Atlanta* will be even worse, because, as the under-water deck does not extend to her ends, she has no protection here but what the thin plating of her side affords. It is true, then, that whereas the protection afforded to the lives of the gun's crews of the *Atlanta* and *Constitution* is of the same resisting power, the power of the main battery to penetrate is in the ratio of 25 : 1 in favor of the later ship. It follows from this, since the men who will fight the ships are much the same, that the *Atlanta's* fighting range is greater than the *Constitution's*. . . .

CLASSIFICATION OF WAR-SHIPS.

A battle ship is as large a ship as can be built, and conveniently and safely be navigated and fought. A frigate —to generalize this term—is a smaller vessel, which, in fleet operations, accompanies the liners, and sees and feels for them. Frigates also perform many minor and very necessary duties. The sloops—to generalize this term also —are sea-going craft smaller than frigates, whose functions are more purely commerce-destroying and protecting

than frigates. We operate, in naval warfare, for the control of the sea, which the enemy tries to hold by his battle-ships, while his own and foreign merchant ships supply him with every necessity. We strive, by bringing his fleets of battle-ships into pitched battles with our own, to destroy the true guardian of his sea power. Our sloops, meanwhile, operate on the merchant ships going to his ports, and evade the battle-ships, whose attention is necessarily engaged by our fleet. Our frigates stand between these two classes, and help each as they can.

Such a view of naval warfare may, perhaps, be accepted as a general one, applicable to any age or combination of weapons. Or, if the precise scheme here drawn up is erroneous, there is yet a general view of the nature here sketched out.

Such a view will, by discovering from the history of wars the object of navies, in some measure help us to decide on the principal characteristics of the various classes, as preliminary to fixing upon the installation of weapons.

The type battle-ship, already mentioned, of about 6,500 tons displacement, comes within the definition of what a battle-ship should be—as large as convenient. We have, in our country, special reasons for limiting the draft of ships to not more than 22 ft. at the outside; and it will be hard to build a ship of 6,500 tons or more with less draft. This ship should carry probably guns of about 12-in. caliber, and, to narrow the matter down still more, two such guns might be mounted in a turret armored with 10 in. or 12 in. of steel; and the ship might carry in addition a battery of numerous 6-in. or 5-in. guns. These should be protected by stout steel shields, of such form as to give efficient protection.

The frigate should be of about 3,500 tons displacement. The ratio between the offense and the defense in these ships should approach that existing in battle-ships. This, it may be observed, is the direct contrary of the rule of practice now adopted; for no vessels of 3,500 tons are *armored*, but are *protected*—to use the phraseology now current—and in all protected ships the offense exceeds the defense far more than in armored ships. This will require frigates—or "second or third-class protected cruisers," as they are frequently called—to be better protected, and their guns to be lighter than now. The protection to the ship herself may be in the way either of a vertical armor-belt at the water-line, or by a protective deck. The guns and gun's-crews must also be protected better than they are now, as a rule. Armor 3 in. or 4 in. thick, and so disposed as to receive blows in a glancing direction, will give protection in many cases, and should be applied athwartships, and wherever necessary on the beam.

To decide upon the offensive and defensive arrangements of a frigate, if we admit a certain ratio of power between these, it is sufficient to decide upon the guns. These should probably be of about 5-in. caliber. Guns of 5-in. caliber, though usually not dangerous to the supposed battle-ship, would yet be so if she were disabled, and if the range were very short. If one or two heavy guns in addition to the battery of 5-in. guns were desired, they should be of full 9-in. bore. My view of large guns in small ships is, however, that they will be useful only in the irregular operations of war—bombardments, the capture of disabled ships of higher rates, etc. The rule will be in the future, as in the past, that vessels will contend with their likes; and of two frigates of 3,500 tons, one carrying two 9-in. guns, and the other an equal weight in twelve 5-in. guns, the latter has certainly the best chance of winning.

The sloop type-ships should be of about 1,500 tons displacement, and their batteries would be mostly of guns of about 4-in. caliber. Here, too, my view is that present types lack in defensive arrangements. The ⅜-in. protective deck of our gunboats and of the class of the English *Archer* will hardly throw off a 3-pounder rapid-fire gun when the range is short; and yet the two classes named are the best protected in the world for their tonnage.

The scheme presented of a convenient classification of war-ships is, of course, open to criticism in all respects; and, perhaps, the best result which can flow from its presentation is the realization of the necessity for a comprehensive plan. The growth of a type of war-ship is an extraordinary and most complex study, and all that any individual can do to fix or control it is infinitesimal in amount.

The scheme presented lays down, from a study of naval wars and of present needs, the three classes of battle-ships, frigates, and sloops. The first we make as big as is safe and convenient; their office is to fight similar ships. The third must be fast sea-going vessels of high coal endurance; their office is to stop the enemy's commerce and protect our own; incidentally they fight vessels of their own class and run away from larger ones. The second—the frigates—are intermediate in every respect; their first duty is to accompany and help the fleet of battle-ships; incidentally they perform all the duties laid down for sloops. We may arrange the three classes in a table as follows:

	Displacement.	Heaviest Gun.	Heaviest Armor.
Battle-ships....	6,500	12 in.	12 in.
Frigates...... ..	3,500	9 "	6 "
Sloops.........	1,500	6 "	4 "

Now, what does our examination of the types of ships teach us of naval tactics—the tactics of sea-battles? In the first place, will the tactics of battle-ships, frigates, and sloops, whether in single combat or fleet actions, differ? If the tactical features of these classes differ as much as they now do, their tactics must differ; but if their tactical features will be the same, their tactics will be the same, as in former times they were the same. That the frigates and sloops shall approach the battle-ships in tactical features, it is necessary that their armor shall increase, and that they shall carry a heavy gun with a large arc of train; a feature now found in many frigates, as the *Charleston, Baltimore, Atlanta, Chicago, Mersey* class, and nearly all French cruisers.

If, then, the tactical features of war-ships of all classes are approaching similarity—the differences being even now more apparent than real—the fighting tactics of all, whether engaged singly or in fleets, will be the same. If the guns of ships are so installed that they have equal all-round fire, they have no preference for one angle of presentment more than another. The line of bearing in fleet formations may then, so far as the question of bringing the guns to bear is concerned, have any direction whatever with respect to the direction in which the enemy is seen. The defensive arrangements of ships—the ratio of their offense to defense on various presentments—will control the range. If these defensive powers approach equality in all directions, as it appears to me logical that they must, if the powers of offense are equal all round, then the gun lays down no tactical rule whatever, except that it prefers that the range should have a certain value. The *Monitors*—to which type the battle-ships of all nations now approach in tactical features—laid down nothing as to the angle of presentment. In a purely gunnery duel between two of them, the only datum we need know, for a complete understanding of the contest, is the range.

A word may be said finally in defense of the use of the old words frigate and sloop, instead of some of the infinity of new names which have been invented to designate vessels whose functions would be the same as those classes. These new names are intended usually to convey something as to the tactical features of a ship—to indicate in some degree how thick her armor is, and how it is disposed; and to show whether her powers of offense are lodged principally in gun, ram, or torpedo. But, as already stated, the existing differences in these respects, except in the matter of armor, are small, and they are growing still smaller; in other words, the sloop of the future may be very nearly produced by a parallel contraction in all respects of the battle-ship.

As to the strain put upon the old meaning of the words sloop and frigate—the meaning with which we are familiar—it is not very great, if we regard the origin of the term. The word frigate passed through a variety of very different meanings, to be applied finally to a ship-rigged war-vessel carrying her guns on one covered deck.

The old term, ship-of-the-line, we have changed to battle-ship; a good name and now firmly lodged in naval terminology. This word alone, among those formerly used to designate different classes of war-ships, has a distinctly military origin. This is probably due to the fact that, of these three classes, the ship-of-the-line alone had a distinctly military origin and purpose.

THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C. E.

(*Continued from page* 118.)

CHAPTER V.

WOODEN CULVERTS.

ON page 214 of Searles's "Field Engineering," paragraph 249, we find the statement, "No wooden culverts should ever be used."

Possibly not, and Mr. Searles might have gone still further and have said that no wooden trestles or wooden bridges should ever be used, as there are undoubtedly serious objections to the use of wood in any of the above-mentioned structures, and iron, steel, or stone would be in every way preferable. But notwithstanding all this, wooden bridges and trestles are used to a great extent, and thousands upon thousands of wooden culverts are in use and continually being built, by our Western railroads in particular.

These culverts undoubtedly give satisfactory results and answer the purpose for which they are constructed, or their use would not be so general upon roads that are not hampered for money and which maintain a high standard of work.

As to the objections to wooden culverts, they are principally as follows:

1. The danger of yielding to the outside pressure of the earth when the wood has become to a certain extent decayed. Any yielding of this nature would not only entirely close the waterway, which would be an exceedingly expensive accident in itself to remedy, but in case of the passage of any great amount of water might lead to various damage to the road in the shape of wash-outs, making a break in the track and thus delaying the traffic.

In case even that there was not sufficient water passing through the culvert at the time to cause any serious damage by itself, still, if the depth of embankment over the top of the culvert was very small, any fall of earth in the culvert would cause a settling of the road-bed to a greater or less extent, and thus cause trouble.

2. The difficulty of examining the timber. This can hardly be called a well-founded objection from the fact that, unless the culvert section is so small that it is impossible for a man to work his way through, this objection can be entirely eliminated by a slight increase in the work of inspection.

When a bank is not of sufficient height to allow of a proper covering over the box culvert, an open culvert is the only remedy; this usually consists of a pile bent on each side of the opening with caps and stringers. The construction of these open culverts will be taken up in detail later. The only point to which we wish to call attention here is that any opening in the track is a most serious objection, and that on a poorly ballasted road, or one with no ballast at all, the objections to openings in the track are increased tenfold, owing to the great difficulty of keeping the track up to grade, particularly at each end of the rigid bearing afforded the rail upon the stringer, so that whenever there is a sufficient height of bank above the top of the culvert, there are many advantages connected with the use of wooden box culverts.

One great drawback to the use of wood in bridges and trestles is the danger from fire. This does not exist in wooden culverts, as they are entirely protected.

One cause that has led to so general a use of wooden culverts, particularly upon new roads of somewhat limited means, is, that they are not only very inexpensive in themselves, but also the ease with which iron pipes can be substituted for them whenever it may be deemed advisable.

In deciding upon the proper size of openings for culverts, the following points must be studied:

1. The area of the water-shed that will empty its water through the culvert.
2. The area of the cross-section of the waterway at the time of the highest known flood.
3. The changes that are liable to take place in any new country, due to the introduction of a railroad and the consequent settling up of the country.

This last-named effect will be shown in two different ways.

1. The swamps will become drained.
2. The smaller streams will entirely disappear.
3. The larger streams will increase in size.

This is due to the facts that not only is the actual number of the streams less, and that all the rain-fall has thus a less number of outlets, but that also very much less of the rain-fall is absorbed by the earth and it is hurried into the streams in much less time than formerly, and thus for a short time increases greatly the amount of water discharged by them. In studying the amount of rain-fall of a section of country in regard to the amount of water that must be passed under the railroad, account should be taken not only of the total number of inches that falls during the entire year, but also of the length of time during which the greater part of the rain falls, because in some sections of country where the total rain-fall is comparatively light, provision on a large scale must still be made for it, owing to the fact that it all comes within a very short time.

Another question to be studied is the topography of the country. In a mountainous section all the rain-fall is precipitated at once into the watercourses, and must be carried off in a short time. This question is one of the most important that has to be studied in connection with the necessary area of waterways.

Many of our American engineers who have worked at different times in tropical countries can fully appreciate the foregoing remarks from sad experience, as the number of culverts on the Mexican railroads that have been carried out during the first rainy season after their construction can be numbered by the hundreds, and this has been due entirely to a failure on the part of the engineers to realize that however small the total amount of rain-fall during the year might be, nearly the whole of this rain-fall came within a very few months, and in some sections was all thrown into the waterways and must be carried off within a few hours after it fell.

In the case of some parts of the Mexican Central Railway this was particularly deceptive, owing to the cross-section of the country through which the line was built. The line of road ran upon a treeless plain that to all appearances was perfectly horizontal. There were no marks of freshets, or evidences that at any time the watercourses had exercised any injurious damaging effect upon the land. The watercourses themselves were few in number, the greater part of them dry, and those that were not dry contained exceedingly little water. This plain extended for miles east and west on each side of the line of the road. As a matter of fact, there was a uniform, although slight, inclination of the whole surface of this plain, and of course the declivity became very steep when the mountains on either side were approached. The actual section of country was what might be called dish-shaped—that is, the ground falls off very rapidly in the mountainous district, while this inclination grows less and less until it becomes a long expanse of country with scarcely any perceptible fall. The consequence is, that after a heavy rain-fall all the water that falls in the mountainous district is thrown at once into the plain, while, owing to the slight inclination in the plain itself, the water that falls there cannot run off with much rapidity, or, at any rate, it cannot run off until after all the water that has fallen in the mountains has joined it. This effect was very much increased by the building of the railroad embankment, which acted as a dam running the whole length of the plain, and a vast body of water accumulated upon one side of it. This was so great as to wash out hundreds of the culverts during the first rainy season.

The reason that there existed no evidences of the immense amount of water which passed down these valleys, from which the engineer might have drawn just conclusions, was that the inclination of the plain was so slight that however large the body of water was, as long as it had free passage it moved so slowly as not to cause any washing of the surrounding country. In any country

where the inclination of the surface is the opposite of this, the opposite result will be obtained—that is, where the surface of the ground near the culvert has considerable slope which gradually grows less as we leave the culvert, then the water that falls in the immediate vicinity of the culvert is at once passed under the embankment, and the water that falls upon the remainder of this drainage area occupies so much more time in getting to the culvert that there is plenty of space for it to pass through when it gets there. This is one point that should be carefully studied by engineers in deciding upon the sectional area necessary for culverts. One year's experience in Mexico has, however, usually been enough to cause engineers to rush to the other extreme, and in some cases has resulted in a most absurd introduction of trestles, and of culverts of large sectional area.

There are innumerable rules and formulas given in various engineering works upon the subject, for calculating the necessary sectional area of any culvert. These formulas are all based upon the following three variables: 1. The area to be drained. 2. The inclination of this area or the time that will be occupied by the water in getting to the culvert. 3. The amount of rain-fall.

Before using any of these formulas, it is necessary to substitute some values for each one of these variables, and, provided the values of these variables are correct, undoubtedly the resulting sectional area for the culvert will be correct. But as it is impossible to assign any more exact values to these variables than those obtained from the best available data combined with the personal good judgment of the engineer in charge, the result obtained by their use is nothing but guess-work, or good judgment, and it is much easier by the use of this same amount of guess-work or good judgment to decide the sectional area necessary for the culvert without the use of the formulas than it is with them—that is, instead of making three guesses, putting these three guesses in the shape of an empirical formula and calculating the sectional area, there is every probability that as correct a result can be obtained by making one guess as to the required sectional area, multiplying that by 2, and using the result in proportioning the culverts.

C. S. F. & C. R. R.

BRIDGE TIE BOX CULVERT

PLATE No. 10.

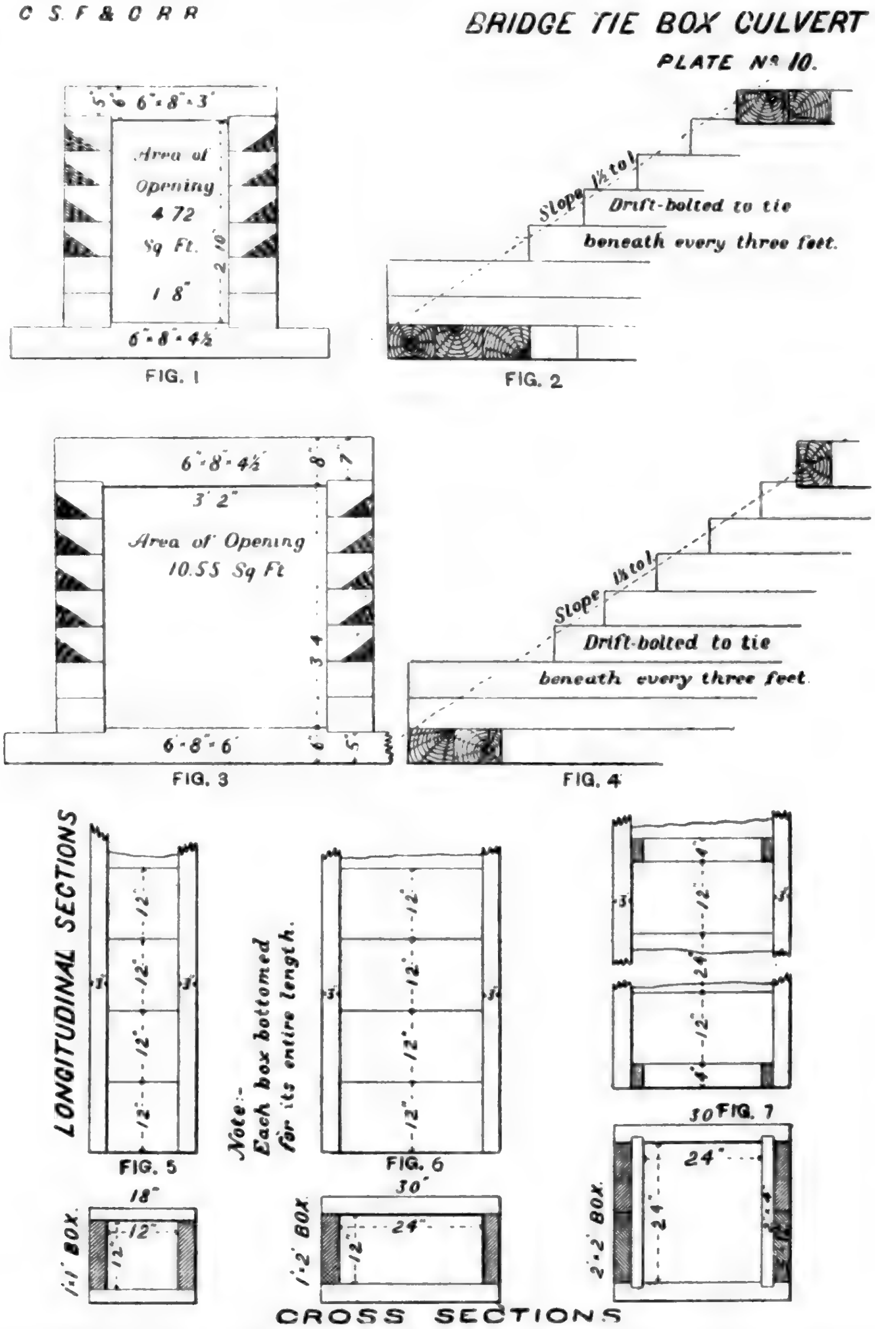


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7

In regard to wooden box culverts, they are for so many reasons preferable to open culverts that the rule should be: WHEREVER THE BANK IS OF SUFFICENT HEIGHT, BOX CULVERTS SHOULD ALWAYS BE USED IN PREFERENCE TO OPEN CULVERTS UP TO A CERTAIN SECTIONAL AREA.

Plate 10 shows, in figs. 5, 6, and 7, cross-sections and longitudinal sections of the standard box culverts of 1 ft. × 1 ft., 1 ft. × 2 ft., and 2 ft. × 2 ft. openings, and figs. 1, 2, 3, and 4 show the *Standard Bridge Tie Box Culverts*

of the Chicago, Santa Fé & California Railroad. The methods of construction are clearly shown in the drawings.

The culverts shown in figs. 1 and 3 are built of bridge ties, not because timber of these dimensions possess any inherent advantages, but for the reason that bridge ties can usually be obtained without much trouble, and this is rather an economical and time-saving adaptation of the means to the desired result than a natural result following the use of available means.

Much time and money can often be saved by just such adaptations as this, and a careful study of the different uses to which all available material may be put, either with the mere object of utilizing the material or in case of emergencies, will well repay every engineer.

Plates 10 A and 11 show the *Standard Wooden Box Culverts* of the Chicago, Milwaukee & St. Paul Railway. The general method of construction is plainly shown in the plans. One point, however, to which we wish to call special attention is that under all circumstances box culverts should be floored throughout their entire length.

This flooring must be watched with care and repaired upon the slightest indication of failure, as upon its completeness depends the whole stability of the culvert.

Care should be taken to protect the upper and lower ends of the culverts in some way from washing.

The flooring should either be extended beyond each end and the sides protected by flaring wings in the shape of sheet piling, or else the upper end should have cobble-stone paving outside. This paving must be raised slightly above the flooring of the culvert, in order to do away with any danger from undermining.

The lower end can in the same way be protected by cobble-stone paving, the top of the paving being slightly below the flooring of the culvert.

Another point to be studied, not only in box culverts, but in all openings for the passage of water under the track, is that the center-line of the culvert should be as nearly at right angles to the center-line of the road as possible, and also that the waterway at each end of the culvert shall be in the prolongation of the axis of the culvert for a sufficient distance each side of the road to diminish the probability of washing in times of exceedingly high water. This point is one of much more importance at the upper end of the culvert than at the lower. If the water-course makes a sharp bend near the entrance of the culvert, there is a strong probability that in time of high water the stream, in place of making this turn and passing through the culvert, will either overflow its ordinary channel or wash its side away and thus impinge upon the railroad embankment and cause a wash-out.

Wooden culverts are built merely as temporary structures to be replaced by iron or stone pipes or stone arches at some future time. This is only following out the general principles upon which the greater part of our American railroads have been constructed. That is, to build the road as cheaply as possible and open it for traffic, then to practically rebuild it out of its earnings. Whether this method is the better one or not is not a question that in most cases will stand discussion, because usually we can build this way or not at all. It is a necessity, not a choice.

In deciding upon the requisite sectional area of wooden box-culverts, they should when possible be given an excess of area sufficient to allow of the introduction of an iron pipe when desired, by simply removing the bottom.

When there is sufficient depth of fill over them, however, to absorb all the force of impact of the passing trains, then, if they have been in use a number of years so that the bank is well compacted, the entire wooden box can be removed with very little danger of any caving in of the earth. Under all circumstances, however, the iron pipe should be put in place as rapidly as possible and the earth well packed around it.

Where a stone arch is not going to be constructed, an iron pipe is in every way preferable to an earthen or stonepipe, owing to the much greater liability of the latter to break.

Below are given bills of the material required in the construction of each of the culverts shown, on a single-track road with road-bed 14 ft. wide. These bills of material are made out for heights of bank from 5 ft. to 30 ft., measuring from profile grade to bottom of culvert.

BILLS OF MATERIAL FOR CULVERTS FOR STATED DEPTHS BELOW GRADE.

No. 13. BRIDGE-TIE CULVERTS.—PLATE 10, FIGS. 1, 2, 3, AND 4.

Depth from Grade to Bottom of Opening.	14 ft. Roadway. No. 1. Ties, 6 in. × 8 in. × 18 ft.	14 ft. Roadway. No. 1. 12-in. Drift-bolts, ¾" dia.	14 ft. Roadway. No. 2. Ties, 6 in. × 8 in. × 18 ft.	14 ft. Roadway. No. 2. 12-in. Drift-bolts, ¾" dia.	16 ft. Roadway. No. 1. Ties, 6 in. × 8 in. × 18 ft.	16 ft. Roadway. No. 1. 12-in. Drift-bolts, ¾" dia.	16 ft. Roadway. No. 2. Ties, 6 in. × 8 in. × 18 ft.	16 ft. Roadway. No. 2. 12-in. Drift-bolts, ¾" dia.
5 ft.	35	254	50	278	40	274	60	312
10 ft.	56	453	75	460	60	418	[illegible]	438
15 ft.	76	556	100	627	80	580	100	654
20 ft.	96	694	125	802	100	718	130	[illegible]
25 ft.	116	858	152	982	120	868	160	1,002
30 ft.	136	1,000	178	1,150	138	1,018	185	1,176

NOTE.—Pieces for roof are not to be cut until walls are laid. Put no pieces in the walls less than 6 ft. long. A 6-ft. piece should have 3 drift-bolts.

No. 14. WOODEN CULVERT.—PLATE 10, FIGS. 5, 6, AND 7.

For 14-ft. roadbed: All material 12 in. × 3 in.

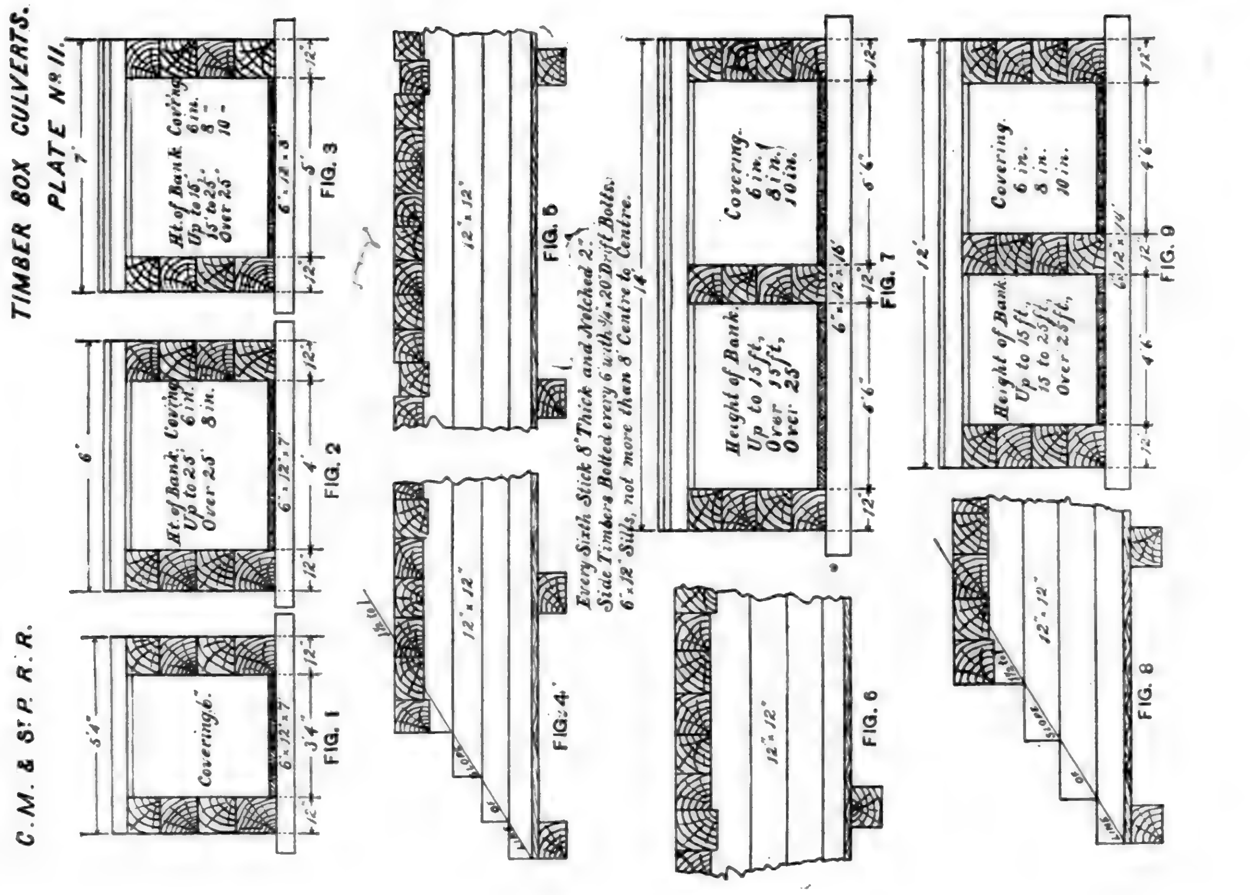
Depth of Fill.	Length of Culvert.	Section 1 ft. × 1 ft.	Section 1 ft. × 2 ft.	Section 2 ft. × 2 ft.	2 in. × 4 in. × 2 ft. 4 in.
		5 lin. ft. per ft. of Length.	7 lin. ft. per ft. of Length.	9 lin. ft. per ft. of Length.	
		Linear ft.	Linear ft.	Linear ft.	
5 ft.	30 ft.	150	210	270	14 pcs.
10 ft.	45 ft.	225	315	405	24 pcs.
15 ft.	60 ft.	300	420	540	32 pcs.
20 ft.	75 ft.	375	525	675	38 pcs.
25 ft.	90 ft.	450	630	810	46 pcs.
30 ft.	105 ft.	525	735	945	54 pcs.

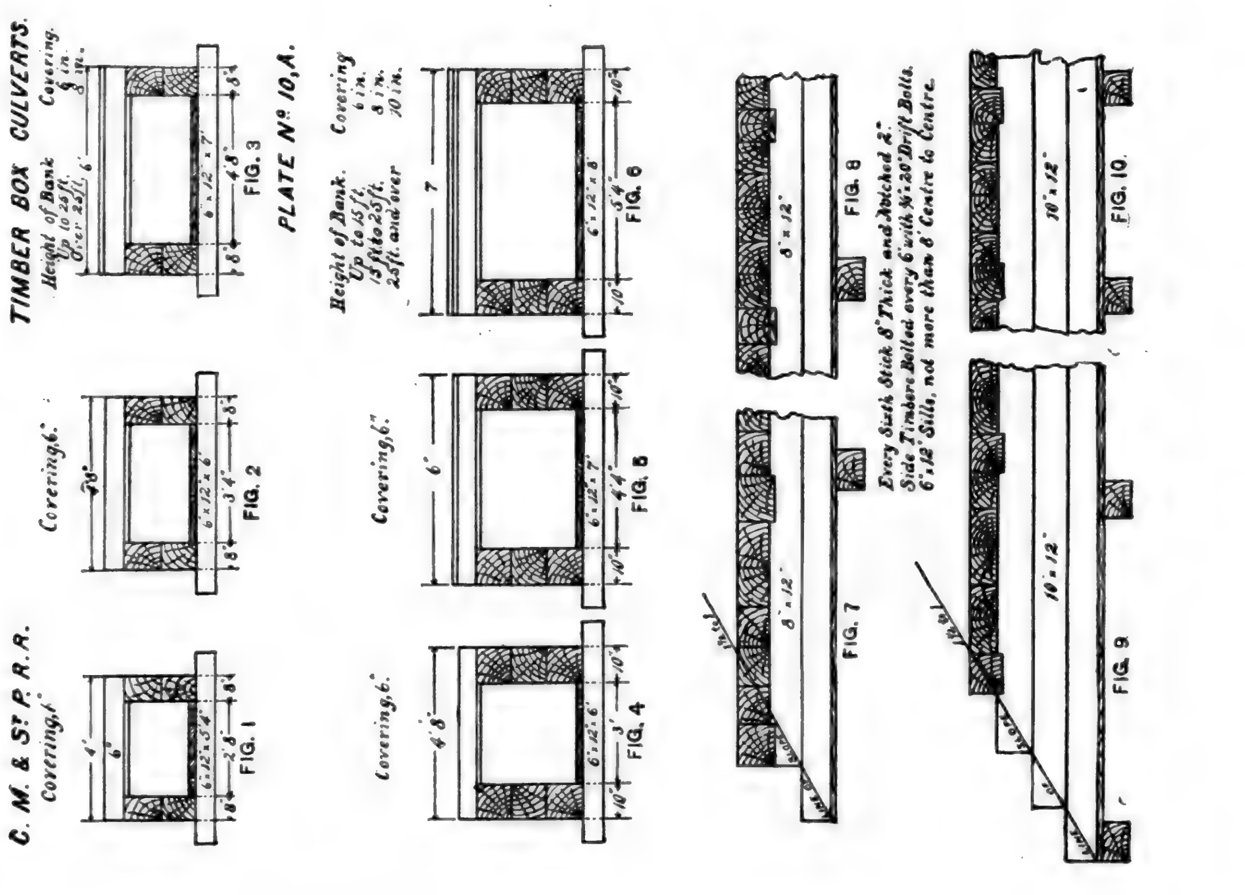
No. 15. WOODEN CULVERT.—PLATE 10A, FIGS. 1 AND 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade. Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 5 ft. 4 in. Sills....	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor........	12	18	24	30	36	42
8 in. × 12 in. × 15 ft. Sides	4	8	12	16	20	24
8 in. × 12 in. × 13 ft. 6 in. Sides...	4	4	4	4	4	4
12 in. × 8 in. × 6 ft. Top..........	5	8	10	13	15	18
6 in. × 12 in. × 6 ft. "	22	34	47	59	72	84
¾ in. × 20 in. Bolts................	18	28	36	44	54	64

No. 16. WOODEN CULVERT.—PLATE 10A, FIGS. 2 AND 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade. Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 6 ft. Sills ...	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.......	14	21	28	35	42	49
8 in. × 12 in. × 15 ft. Sides.......	4	8	12	16	20	24
8 in. × 12 in. × 13 ft. 6 in. Sides..	4	4	4	4	4	4
8 in. × 12 in. × 4 ft. 8 in. Top..	5	8	10	13	15	18
6 in. × 12 in. × 4 ft. 8 in. "	22	34	47	59	72	84
¾ in. × 20 in. Bolts...	18	28	36	44	54	64


C. M. & St. P. R. R.
TIMBER BOX CULVERTS.
PLATE No. 11.
Covering, 6"
FIG. 1
Ht. of Bank. Covering
Up to 25' 6 in.
Over 25' 8 in.
FIG. 2
Ht. of Bank. Cov'ing
Up to 15' 6 in.
15' to 25' 8 "
Over 25' 10 "
FIG. 3
12"x12"
FIG. 4
FIG. 5
Every Sixth Stick 8" Thick and Notched 2".
Side Timbers Bolted every 6' with 3/4"x20" Drift Bolts.
6"x12" Sills, not more than 8' Centre to Centre.
FIG. 6
Height of Bank. Covering.
Up to 15 ft. 6 in.
Over 15 ft. 8 in.
Over 25 ft. 10 in.
FIG. 7
FIG. 8
Height of Bank. Covering.
Up to 15 ft. 6 in.
15 to 25 ft. 8 in.
Over 25 ft. 10 in.
FIG. 9


C. M. & St. P. R. R.
TIMBER BOX CULVERTS.
PLATE No. 10, A.
Covering, 6"
FIG. 1
Covering, 6"
FIG. 2
Height of Bank. Covering.
Up to 25 ft. 6 in.
Over 25 ft. 8 in.
FIG. 3
Covering, 6"
FIG. 4
Covering, 6"
FIG. 5
Height of Bank. Covering
Up to 15 ft. 6 in.
15 ft. to 25 ft. 8 in.
25 ft. and over 10 in.
FIG. 6
8"x12"
FIG. 7
FIG. 8
Every Sixth Stick 8" Thick and Notched 2".
Side Timbers Bolted every 6' with 3/4"x20" Drift Bolts.
6"x12" Sills, not more than 8' Centre to Centre.
10"x12"
FIG. 9
FIG. 10

No. 17. Wooden Culvert.—Plate 10a, Figs. 3 and 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	18	27	36	45	54	63
8 in. × 12 in. × 15 ft. Sides	4	8	12	16	20	24
8 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
8 in. × 12 in. × 6 ft. Top	5	8	10	13	15	102
6 in. × 12 in. × 6 ft. "	22	34	47	59	72	..
¾ in. × 20 in. Bolts	18	28	36	44	54	64

No. 18. Wooden Culvert.—Plate 10a, Figs. 4 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 6 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	12	18	24	30	36	42
10 in. × 12 in. × 15 ft. Sides	4	10	16	22	28	34
10 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 12 ft. Sides	4	4	4	4	4	4
8 in. × 12 in. × 4 ft. 8 in. Top	5	7	9	12	14	17
6 in. × 12 in. × 4 ft. 8 in. "	16	29	42	54	67	79
¾ in. × 20 in. Bolts	28	40	54	68	82	96

No. 19. Wooden Culvert.—Plate 10a, Figs. 5 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	18	27	36	45	54	63
10 in. × 12 in. × 15 ft. Sides	4	10	16	22	28	34
10 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 12 ft. Sides	4	4	4	4	4	4
8 in. × 12 in. × 6 ft. Top	5	7	9	12	14	17
6 in. × 12 in. × 6 ft. "	16	29	42	54	67	79
¾ in. × 20 in. Bolts	28	40	54	68	82	96

No. 20. Wooden Culvert.—Plate 10a, Figs. 6 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 8 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	22	33	44	55	66	77
10 in. × 12 in. × 15 ft. Sides	4	10	16	22	28	34
10 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 12 ft. Sides	4	4	4	4	4	4
10 in. × 12 in. × 7 ft. Top	..	..	..	12	14	105
8 in. × 12 in. × 7 ft. "	5	7	9	14	67	..
6 in. × 12 in. × 7 ft. "	16	29	42	..	..	..
¾ in. × 20 in. Bolts	28	40	54	68	72	96

No. 21. Wooden Culvert.—Plate 11, Figs. 1 and 4.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	14	21	28	35	42	49
12 in. × 12 in. × 15 ft. Sides	4	12	20	28	36	44
12 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
12 in. × 12 in. × 12 ft. Sides	4	4	4	4	4	4
12 in. × 12 in. × 10 ft. 6 in. Sides	4	4	4	4	4	4
8 in. × 12 in. × 5 ft. 4 in. Top	4	6	9	11	14	16
6 in. × 12 in. × 5 ft. 4 in. "	14	27	39	52	64	77
¾ in. × 20 in. Bolts	34	52	70	90	110	130

No. 22. Wooden Culvert.—Plate 11, Figs. 2 and 4.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floors	16	24	32	40	48	56
12 in. × 12 in. × 15 ft. Sides	4	12	20	28	36	44
12 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
12 in. × 12 in. × 12 ft. Sides	4	4	4	4	4	4
12 in. × 12 in. × 10 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 6 ft. Top	..	..	..	..	..	16
8 in. × 12 in. × 6 ft. "	4	6	9	11	14	77
6 in. × 12 in. × 6 ft. "	14	27	39	52	64	..
¾ in. × 20 in. Bolts	34	52	70	90	110	130

No. 23. Wooden Culvert.—Plate 11, Figs. 3 and 4.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 8 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	20	30	40	50	60	70
12 in. × 12 in. × 15 ft. Sides	4	12	20	28	36	44
12 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
12 in. × 12 in. × 12 ft. Sides	4	4	4	4	4	4
12 in. × 12 in. × 10 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 7 ft. Top	..	..	..	11	14	93
8 in. × 12 in. × 7 ft. "	4	6	9	52	64	..
6 in. × 12 in. × 7 ft. "	14	27	39	..	..	..
¾ in. × 20 in. Bolts	34	52	70	90	110	130

CHAPTER VI.

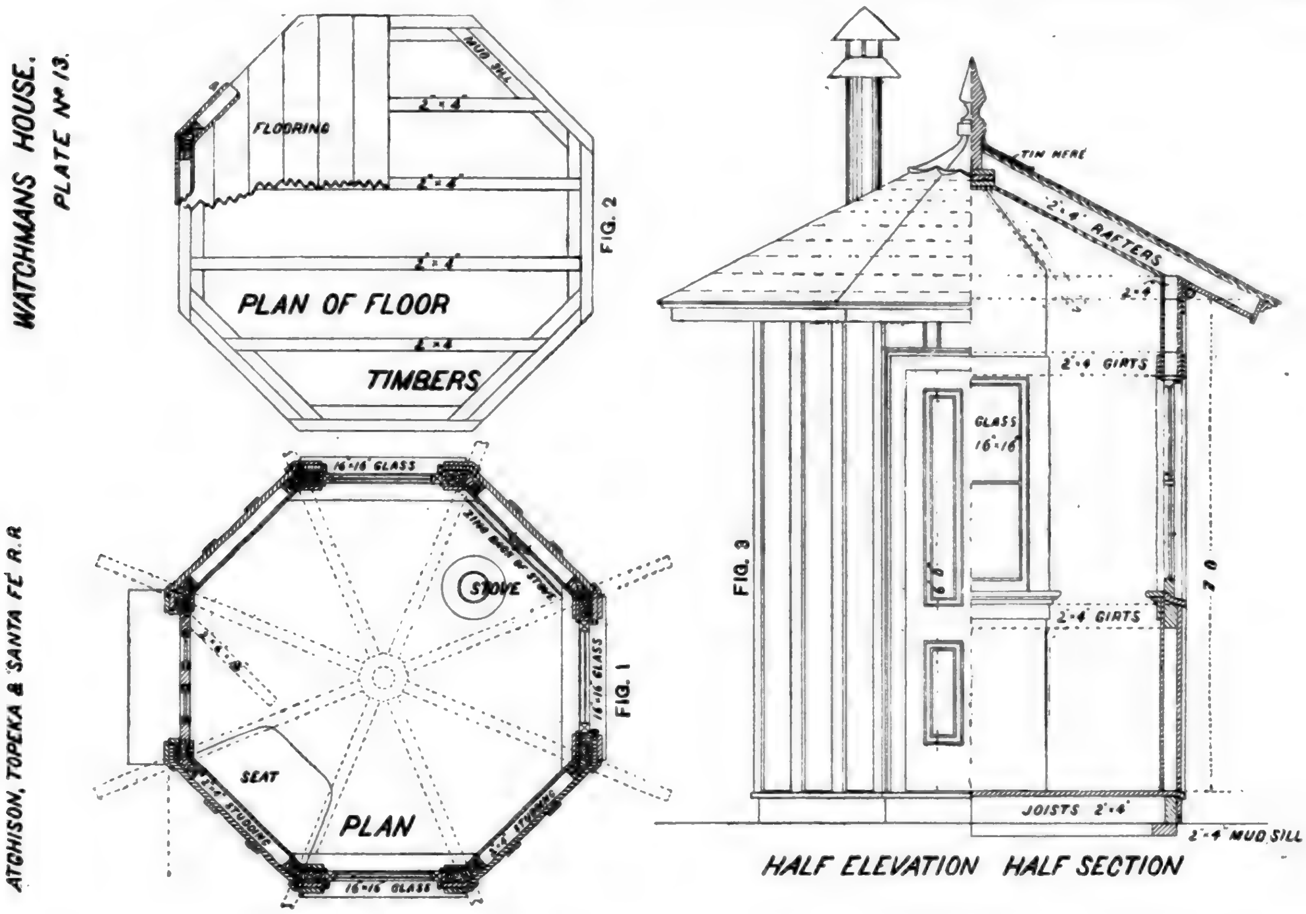
HAND-CAR AND TOOL HOUSES.

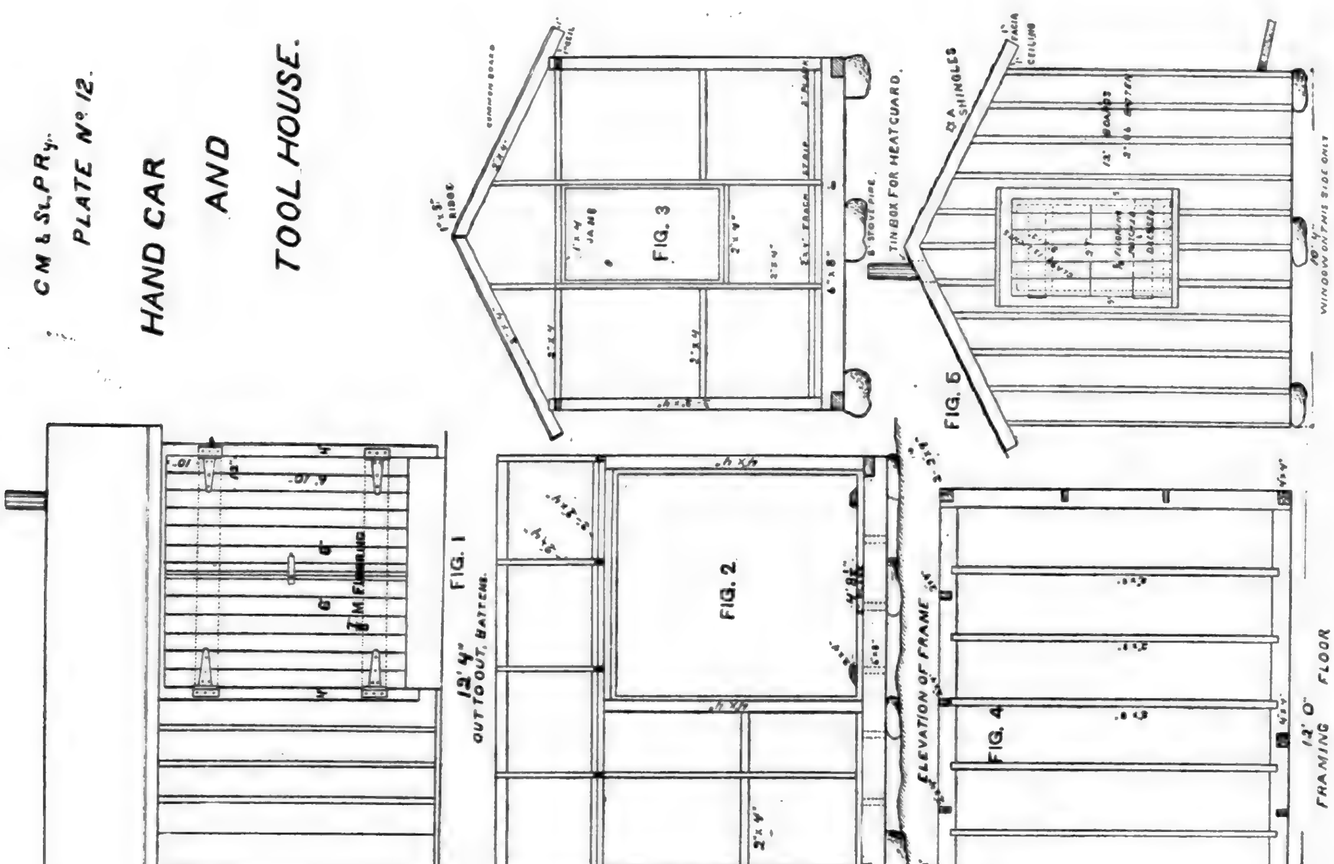
Plate 12, figs. 1, 2, 3, 4 and 5, show plans and elevation of the *Standard Hand-Car and Tool House* of the Chicago, Milwaukee & St. Paul Railway.

The object of these houses is to hold the hand-car and all the tools and small material used by a section gang.

A house of the size shown in the plate is sufficient for all purposes of storage of the car, tools, spikes, bolts, etc., and also to allow the men to move around with ease and carry on any work that may be desirable.

As shown in the plate, these houses are furnished with a stove and have a window in one end. They should be


WATCHMANS HOUSE.
PLATE No 13.
ATCHISON, TOPEKA & SANTA FE R.R.
FLOORING
MUD SILL
PLAN OF FLOOR
TIMBERS
FIG. 2
16"×16" GLASS
STOVE
SEAT
PLAN
FIG. 1
2"×4" STUDDING
FIG. 3
TIN HERE
2"×4" RAFTERS
2"×4" GIRTS
GLASS 16"×16"
JOISTS 2"×4"
2"×4" MUD SILL
HALF ELEVATION HALF SECTION


C M & St P Ry.
PLATE No 12.
HAND CAR
AND
TOOL HOUSE.
FIG. 1
FIG. 2
FIG. 3
FIG. 4
FIG. 5
12' 4"
OUT TO OUT, BATTENS.
TIN BOX FOR HEATGUARD.
SHINGLES
ELEVATION OF FRAME
12' 0" FLOOR FRAMING

No. 24. Wooden Culvert.—Plate 11, Figs. 6 and 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 16 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	44	66	88	110	132	154
12 in. × 12 in. × 15 ft. Sides	6	18	30	42	54	66
12 in. × 12 in. × 13 ft. 6 in. Sides	6	6	6	6	6	6
12 in. × 12 in. × 12 ft. Sides	6	6	6	6	6	6
12 in. × 12 in. × 10 ft. 6 in. Sides	6	6	6	6	6	6
10 in. × 12 in. × 14 ft. Top	..	..	..	11	14	93
8 in. × 12 in. × 14 ft. "	4	6	9	52	64	..
6 in. × 12 in. × 14 ft. "	14	27	39	..	..	..
¾ in. × 20 in. Bolts	34	52	70	90	110	130

No. 25. Wooden Culvert.—Plate 11, Figs. 8 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 8 in. × 14 in. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	36	54	72	90	108	126
12 in. × 12 in. × 15 ft. Sides	6	18	30	42	54	66
12 in. × 12 in. × 13 ft. 6 in. Sides	6	6	6	6	6	6
12 in. × 12 in. × 12 ft. Sides	6	6	6	6	6	6
12 in. × 12 in. × 10 ft. 6 in. Sides	6	6	6	6	6	6
10 in. × 12 in. × 12 ft. Top	..	..	..	11	14	93
8 in. × 12 in. × 12 ft. "	4	6	9	52	64	..
6 in. × 12 in. × 12 ft. "	14	27	39	..	..	..
¾ in. × 20 in. Bolts	34	52	70	90	110	130

provided with a bench across one end, and with a number of lockers.

They should stand parallel with the track and at a sufficient distance from it to allow of the hand-car standing between them and the track, without any danger of being struck by passing trains. The rails of the car-house should be below the level of the main track, in order to eliminate all possibility of the car getting loose and running on to the track.

The door of the house can be either hung on hinges, as shown in the plate, or else be a sliding door. There are advantages connected with the use of both, but leaving the slight increase of expense out of the question, the sliding doors are, on the whole, preferable.

When possible, the house should stand next to a side track rather than to the main line, so that in removing the car from the track the section men are in no way interfering with the main line.

When the siding, however, is much used and there is a liability of its being occupied the greater part of the time by cars, then it is not possible to have the house stand next to it, owing to the great inconvenience and loss of time it would occasion the section men.

No. 26. Bill of Material for Hand Car and Tool House.

Plate No. 12.

2 pieces .... 6 in. × 8 in. × 10 ft.
2 pieces .... 6 in. × 8 in. × 12 ft.
5 pieces .... 2 in. × 8 in. × 9 ft. 6 in.
9 pieces .... 2 in. × 4 in. × 8 ft.
2 pieces .... 4 in. × 4 in. × 8 ft.
7 pieces .... 2 in. × 4 in. × 10 ft.
2 pieces .... 2 in. × 4 in. × 3 ft. 6 in.
1 piece .... 2 in. × 4 in. × 12 ft.
1 piece .... 2 in. × 4 in. × 5 ft.
10 pieces .... 2 in. × 4 in. × 7 ft. rafters.
4 pieces .... 1 in. × 4 in. × 7 ft. facia.
2 pieces .... 1 in. × 4 in. × 13 ft. facia.
1 piece .... 1 in. × 5 in. × 13 ft. ridge.
4 pieces .... 2 in. × 4 in. × 12 ft. plates.
500 ft. B. M. 1-in. boards, 12 in. wide.
2 ft. B. M. 2 in. × 4 in. × 10 ft. track strip.
240 ft. B. M. 2-in. plank floor.
325 lin. ft. 2-in. battens.
1 double door, 6 ft. 6 in. wide × 7 ft. long, made of ⅞-in. matched flooring.
1 window sash, 12 lights, 9 in. × 12 in.
1 window shutter, ⅞-in. matched flooring.
4 door hinges with 12-in. strap, as per drawing.
2 door hinges.
1 hasp and staple for door.
1 hook for shutter.
1 piece zinc 2 ft. 6 in. × 3 ft.
10 lbs. 4 d. nails.
¼ keg 8 d. nails.
¼ keg 10 d. nails.
13 lbs. paint.
500 A. shingles or galvanized corrugated iron.
Tin box for heat guard.

CHAPTER VII.

WATCHMAN'S HOUSES.

Plate 13 shows the plan and elevation of an octagonal *Watchman's House*, as built upon the Atchison, Topeka & Santa Fé Railroad.

These houses are required to be large enough simply to accommodate the watchman and afford a place for a stove, in case the climate is such as to necessitate the use of one. They are situated at switches, road crossings, or any other place where it is necessary to have a watchman, and as he must of necessity be inside the house during inclement weather, one point that should be carefully studied is a sufficiency of windows to allow him a clear view of the track in both directions and also of the road crossing and whatever else it may be his duty to watch. This is accomplished in a most economical and satisfactory fashion by making the house octagonal, as shown in the drawing. Then the space occupied by the stove does not obstruct the view in any direction, and the windows, together with the door, permit a clear view in every direction.

Another point that should be studied in the construction of this house is that the framing should be put together in such a manner that the house may be moved from one point to another the same as a box, whenever the occasion requires. In this regard, also, the octagonal shape possesses a great many advantages over the ordinary rectangular form.

It is better to make the roofs of these houses of corrugated galvanized iron, as it decreases the risk from fire.

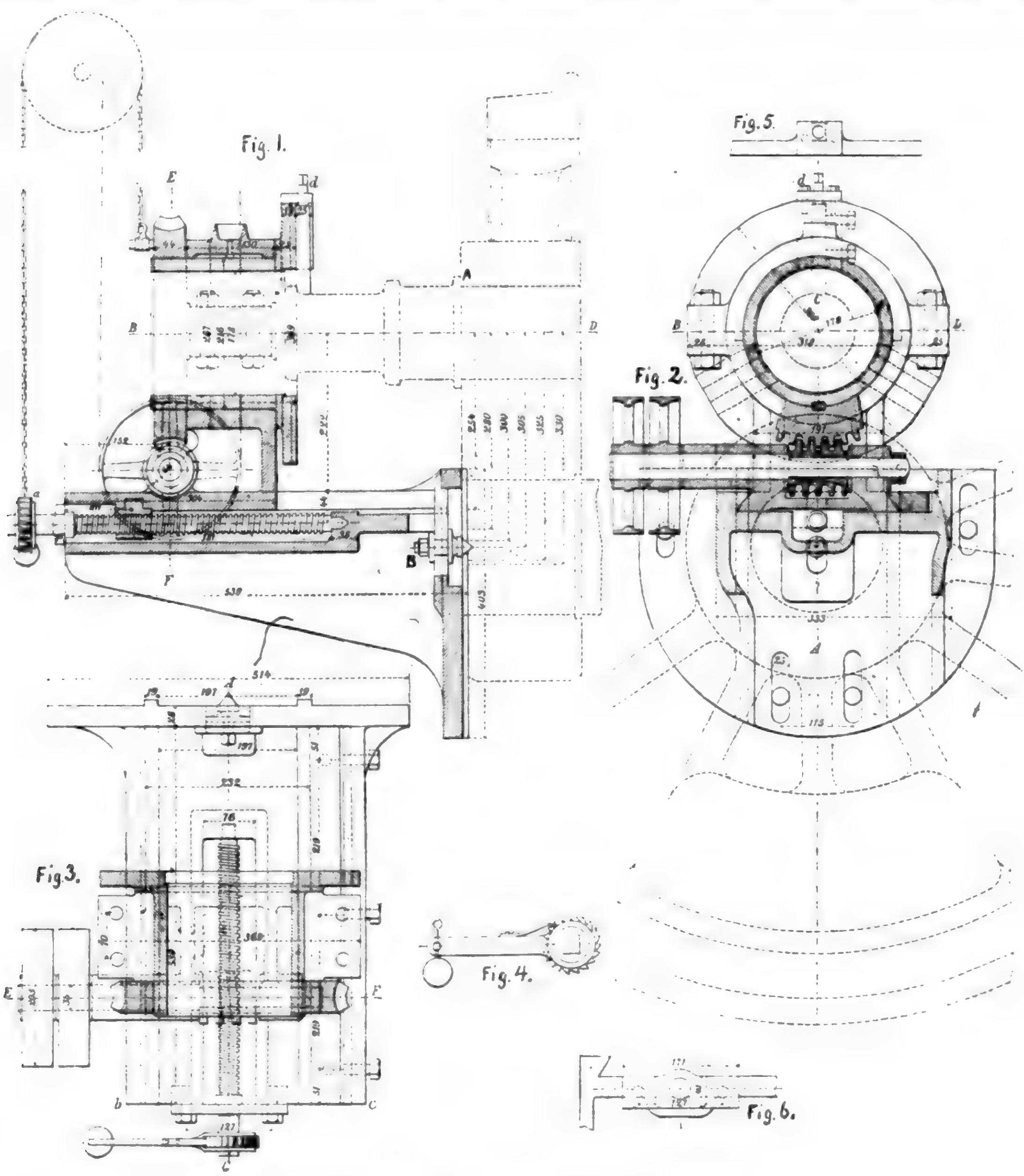
No. 27. Bill of Material for Watchman's House, 6 ft. Diameter.

Plate No. 13, Figs. 1, 2, and 3.

4 pieces sills and mud sills .... 2 in. × 4 in. × 12 ft.
1 piece sills and mud sills .... 2 in. × 4 in. × 16 ft.
2 joists .... 2 in. × 4 in. × 18 ft.
8 studs .... 2 in. × 4 in. × 14 ft.
3 girts and plates .... 2 in. × 4 in. × 14 ft.
1 octagon cap for rafters to butt on at apex of roof .... 8 in. diam. out of 3 pieces of plank
1 turned terminal .... 5 in. diam. and 22 in. high.
130 ft. B. M. 1 in. × 10 in. × 16 ft. for outside.
160 ft. B. M. ⅝ in. × 6 in., beaded sheathing.
80 ft. B. M. roofing boards.
800 star shingles.
21 lin. ft. 1 in. × 6 in. frieze board.
21 lin. ft. moulding No. 159, H. & W.
62 ft. B. M. ⅞ in. × 6 in., flooring for soffit of eaves and floor.
10 O. G. battens, 3 in. × 16 ft. long, outside.
28 lin. ft. ⅞ in. × 4 in. facia.
23 lin. ft. moulding No. 31, H. & W.

Doors and Windows.

1 door .... 2 ft. × 6 ft. × 1⅜ in. four-panel raised O. G.
1 sill .... ⅞ in. × 10 in. × 2 ft. 6 in.
1 jamb .... ⅞ in. × 3⅝ in. × 12 ft.
1 head .... ⅞ in. × 3⅝ in. × 2 ft. 4 in.
1 outside casing .... ⅞ in. × 4 in. × 12 ft.



URQUHART'S CRANK-PIN LATHE.

1 head .... 7/8 in. × 4 in. × 3 ft.
1 inside casing............ 7/8 in. × 4 in. × 12 ft.
1 head .... 7/8 in. × 4 in. × 3 ft.
3 sashes .... 1 3/8 in., 2 lights, 16 in. × 16 in. glass
3 outside casings.......... 7/8 in. × 4 in. × 7 ft. 6 in.
3 heads.................... 7/8 in. × 4 in. × 2 ft. 4 in.
3 outside stops .... 5/8 in. × 1 3/8 in. × 8 ft.
3 rabbitted sills.......... 1 3/8 in. × 4 in. × 2 ft. 4 in.
3 inside casings .... 7/8 in. × 4 in. × 7 ft. 6 in.
3 heads.................... 7/8 in. × 4 in. × 2 ft. 4 in.
3 inside sills .... 7/8 in. × 3½ in. × 2 ft. 8 in
3 apron pieces............. 7/8 in. × 4 in × 2 ft. 4 in.
1 piece moulding No 61, H. & W., 7 ft long.

Hardware.

1 rural night latch, left hand.
1 left-hand thumb latch.
1 piece zinc, 2 ft. 6 in. × 2 ft. 8 in.
¼ keg 10 d. nails.
¼ keg 8 d. nails.
7 lbs. 4 d. nails.
10 ft. flashing tin, 14 in. wide.

Paint.

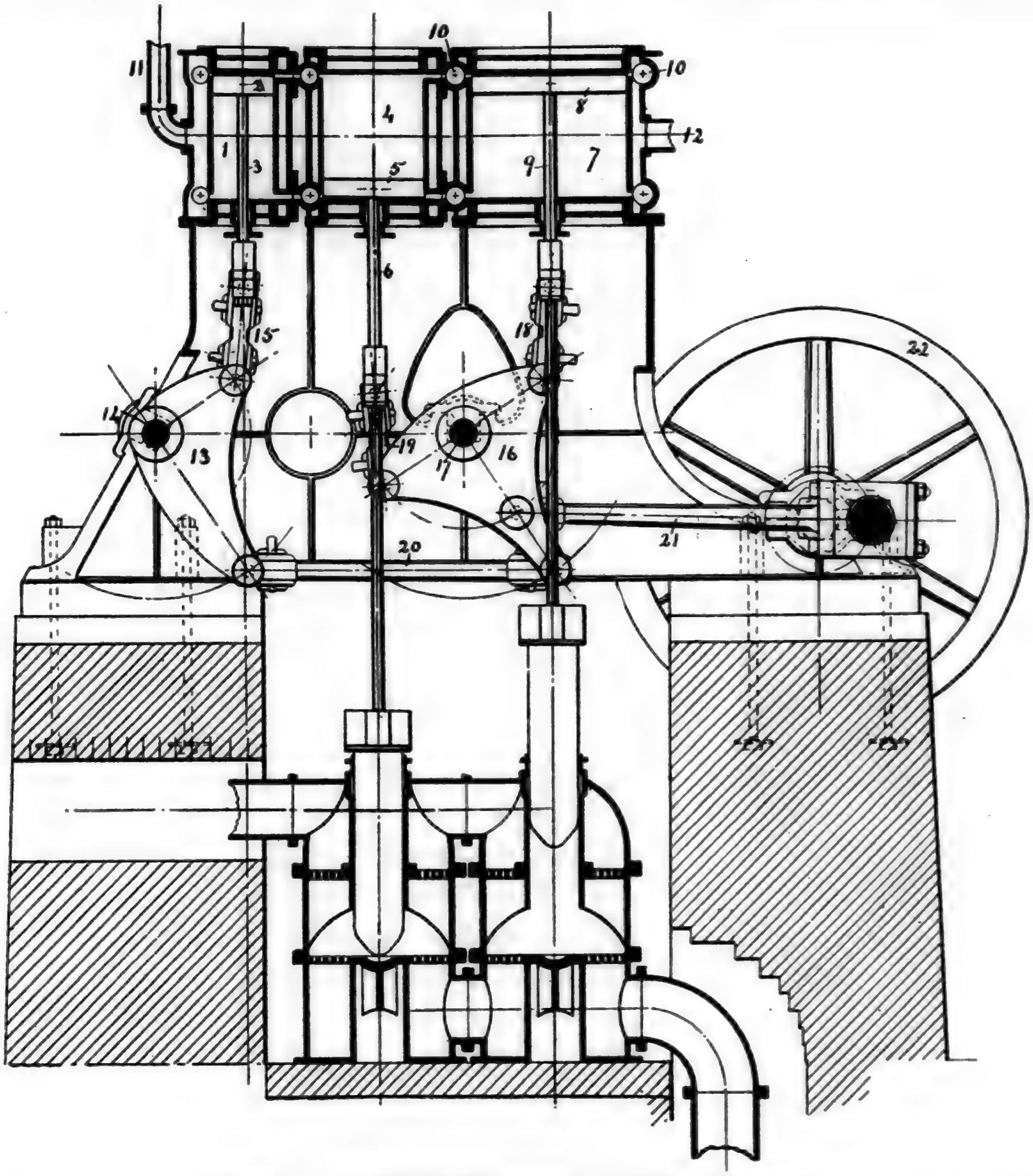
3 gals. Asbestos paint.
1 gal. boiled linseed-oil.
5 lbs. putty.

The amount of expense that may be justifiable in order to ornament and beautify these houses depends entirely upon the location of the house, although from a standpoint of economy, the house should always be neatly painted and everything about it should be kept as neat and clean as possible. This principle not only applies to watchmen's houses, but to all other buildings connected with a railroad, and even if it necessitates a little additional expense, this expense is well repaid to the road in actual saving of material. Under all circumstances, order and neatness should be inculcated in railroad employés. The mere fact that a watchman is obliged to sweep out his house every day and keep everything picked up, not only preserves the house, but makes him in every respect a better and more trustworthy watchman.

(TO BE CONTINUED.)

A MACHINE FOR TURNING UP LOCOMOTIVE CRANK-PINS.

THE accompanying illustrations show a very neat and convenient tool for turning up locomotive crank-pins, designed by Mr. Thomas Urquhart, Chief Mechanical Engineer of the Griasi-Tzaritzin Railroad. Several of these machines are now, and have been for some time, in use on that road, with excellent results, and the machine has



GASKILL'S TRIPLE-EXPANSION PUMPING ENGINE.

been patented by Mr. Urquhart, both in Europe and in this country.

In the accompanying illustrations, fig. 1 is a cross-section on the line *A C*, figs. 2 and 3; fig. 2 is a section on the line *E F*, figs. 1 and 3; fig. 3 is a section on the line *E D*, figs. 1 and 2; fig. 4 is a side view of the ratchet, the end view of which is shown on the left of fig. 1; fig. 5 is a plan of *d*, figs. 1 and 2; fig. 6 is a view of *a b*, fig. 3.

The construction of this tool is very simple, and can be readily understood from the drawings. The general plan of the machine is an angular bed-plate of cast iron, which serves as a support for the gearing, and a ring-shaped head carrying the cutting tool and the gearing, from which it derives its motion, through a worm-wheel and worm carried on the main shaft, which is driven by a belt. The bed-plate can be fastened to the driving-wheel by means of clamping bolts passing between the spokes of the wheel.

In use the machine is set true to the unworn collar *A* at the base of the crank-pin; the movable center *B* can be arranged for any radius of crank. The head-stock makes from 4 to 4½ revolutions per minute.

The Griasi-Tzaritzin Railroad is about 500 miles in length and is equipped with 143 locomotives, 60 of which have eight wheels coupled. Two of these tools, at the Central Shops in Borisoglebsk, keep all the worn crank-pins in excellent order, the almost absolute correctness of the centers of the pins when trued up being remarkable, while the finish given by the spring tool is excellent. We are informed that the saving in crank-pins, connecting-rod brasses, and in oil is very considerable, while the engines run with unusual smoothness, and pounding and heating of brasses is almost unknown.

A TRIPLE-EXPANSION PUMPING ENGINE.

The accompanying illustration shows a design for a triple expansion engine, recently patented by Mr. Harvey F. Gaskill, of Lockport, N. Y. The drawing is a vertical section through the cylinders, showing also the pumps, the foundation, and the peculiar arrangement of cranks.

The object of Mr. Gaskill's design is to make the steam passages between the cylinders short and direct, dispensing with intermediate receivers. It will be seen from the illustration that the cylinders are so arranged and connected that the pistons 2 and 8 of the high and low-pressure cylinders move together, while the piston 5 of the intermediate cylinder moves in an opposite direction to the other two. By this arrangement steam is exhausted directly from the end of the cylinder in which it has just done its work into the cylinder of the next succeeding grade.

The connecting rods of the low-pressure and intermediate cylinders are coupled to a triangular beam, 16, which oscillates about the center 17, while the high-pressure cylinder connects by a link or short connecting rod with

the bell-crank beam 13, which oscillates about a center, 14. The lower ends of the two beams 16 and 13 are connected together by a coupling-rod, 20, and another coupling-rod, 21, connects the beam 16 with a crank-shaft upon which is the fly-wheel 22.

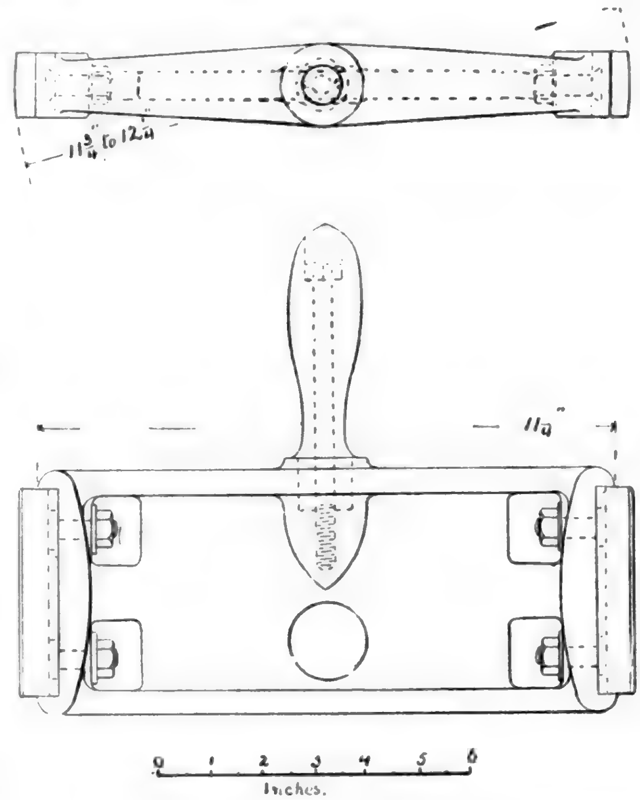
In the arrangement of pumps shown in the drawing, single-acting pumps are used, arranged in line with the low-pressure and intermediate cylinders, and operated directly from their piston-rods. Other arrangements of the pumps can, of course, be used, and the placing of the pumps is not part of the patent.

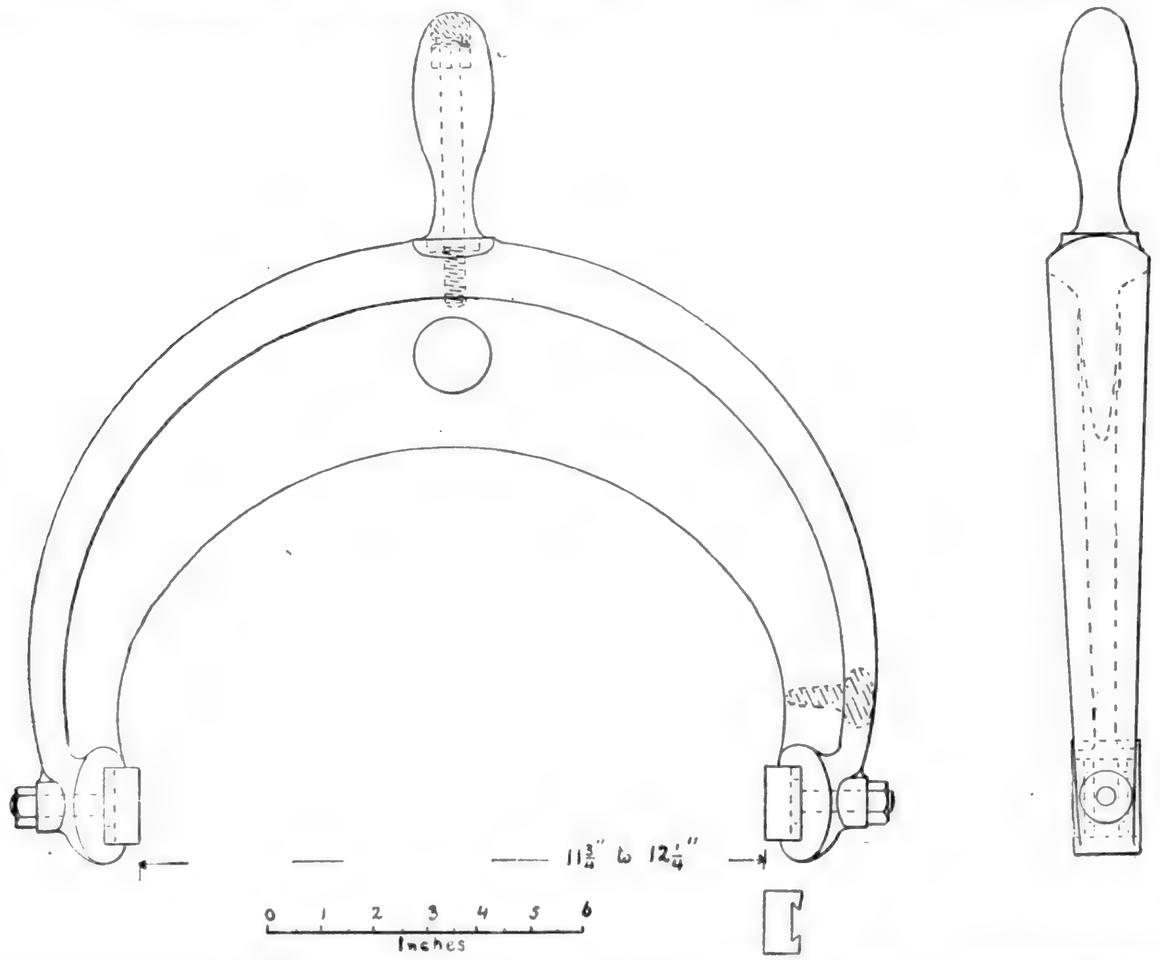
In operation, supposing the piston of the high-pressure cylinder 1 to be moving on its down stroke, the steam in the lower end of that cylinder will pass directly into the lower end of the intermediate cylinder 4 and force its piston 5 upward, and the steam remaining from the former stroke in the upper end of the cylinder 4 will expand into the upper end of the low-pressure cylinder 7 and force its piston 8 downward; the steam remaining in the lower end of the cylinder 7 from the last preceding stroke will be exhausted at 12. Thus it will be seen that the steam expands from one cylinder into the next lower grade through the shortest possible passage, this passage being only long enough to go through the walls of the cylinder and give room for the controlling valve.

The patent claims cover the arrangement of the cylinders and pistons, the beams and connecting-rods—that is, simply the arrangement and connection of the different parts of the engine.

Fixed Caliper Gauges.

THE accompanying illustrations show two fixed caliper gauges on a new plan. The object of their construction is to save expense in the large sizes by making the body of the gauge of cast iron, the heels and points being made of steel fitted to these bodies, hardened and ground to size. This arrangement has the further advantage that the heels and points can be renewed from time to time, as required. The handles are made of wood and the gauge is therefore less affected by the heat of the hand in using. The illustrations show a male and female gauge on this plan on a scale of one-quarter size; the construction is so simple that it will be readily understood from the drawings. As will be seen, the heels and points are fastened to the body of the gauge by bolts, making their adjustment easy.





These gauges are made by James A. Taylor & Company at the American Standard Gauge & Tool Works, Wilmington, Del.

CATECHISM OF THE LOCOMOTIVE.

(*Revised and enlarged.*)

By M. N. Forney.

(*Continued from page 142.*)

CHAPTER XXV. (*Continued.*)

THE WESTINGHOUSE AUTOMATIC AIR BRAKE.

Question 651. *Where is the air pump for operating the brakes usually located?*

Answer. It is generally attached to the right-hand side of the fire-box or further forward on the boiler. See 1 Plate VI.

Question 652. *How is the air pump constructed?*

Answer. Fig. 380, which represents a vertical section of such a pump, shows its construction. It consists of a steam cylinder, 3, and an air cylinder, 5. Both of these cylinders have pistons, 11 and 14, which are connected together by a piston-rod, 11. Steam taken from the locomotive boiler is admitted to the upper cylinder by a pipe, *A*. The upper piston is operated by the steam pressure in the cylinder 3, and moves the lower one, which compresses the air in cylinder 5. The steam from the boiler enters the upper cylinder between the two small piston-valves 34 and 38. The upper piston 34 being of greater diameter than the lower one, the tendency of the pressure is to raise the pistons, unless they are held down by the pressure of a third piston, 30, of still greater diameter, which works in a cylinder directly above 34, and bears on the rod 32. The pressure on this third piston is regulated by the small slide-valve 23, which works in the central chamber 24 on the top cylinder-head. This valve receives its motion from a small rod, 22, which is connected to the valve 23 and extends into the hollow piston-rod 11. The small rod has a knob on its lower end and a shoulder, *S*, just below the top head. A steam passage, not shown in the engraving, connects the valve chamber 24 with the steam space *B* between the pistons 34 and 38. The steam acting on the third piston 30 holds the piston-valves 34 and 38 down and enters the cylinder 3 through the openings at 40 and pushes the main piston 11 up in its cylinder. As the main piston approaches the upper end of the cylinder the shoulder 20 on the piston strikes the shoulder *S* on the rod 22 and pushes it and the valve 23 upward. This allows the steam in the cylinder *C* to escape and relieve the pressure above the piston 30. The steam pressure below the piston-valve 34 then pushes it and the valve 38 upward, which admits steam into the upper end of the cylinder 3, and also allows that in the lower end to escape through the openings at 38. The piston 11 is thus forced down in the cylinder until the shoulder 20 comes in contact with the knob on the end of the rod 22, which moves the slide-valve 23, and again admits steam into the cylinder *C* above the piston 30, and the action is repeated. The exhaust chambers at 36 and 38 communicate with the pipe 61, through which steam is exhausted. This pipe is indicated by 25 in Plate VI.

Question 653. *How is the air cylinder of the air pump constructed?*

Answer. It has air inlets at 48 and 51 and conical valves 45, 46, 49, and 50 above and below these inlets. When the piston 14 descends it compresses the air below it, which closes valve 50 and raises and opens 49, so that the compressed air passes into the chamber *D* and through the pipe 53—indicated by 7 in Plate VI—into the main reservoir. At the same time a partial vacuum is produced above the piston, which causes the atmospheric pressure below valve 46 to raise it, thus allowing air to flow into the cylinder through the air inlets at 48. The chamber above 45 is connected with the chamber *D* and main reservoir, so that when the pressure in them is greater than that below the valve 45, it is forced down on its seat and closed. The reverse action takes place when the piston 14 ascends—that is, valve 50 opens to admit air below the piston and 49 is closed by the pressure above it. At the same time 46 is closed and 45 opens, so that the air which is compressed above the piston flows through the valve 45 to the chamber *D*, and thence into the main reservoir.

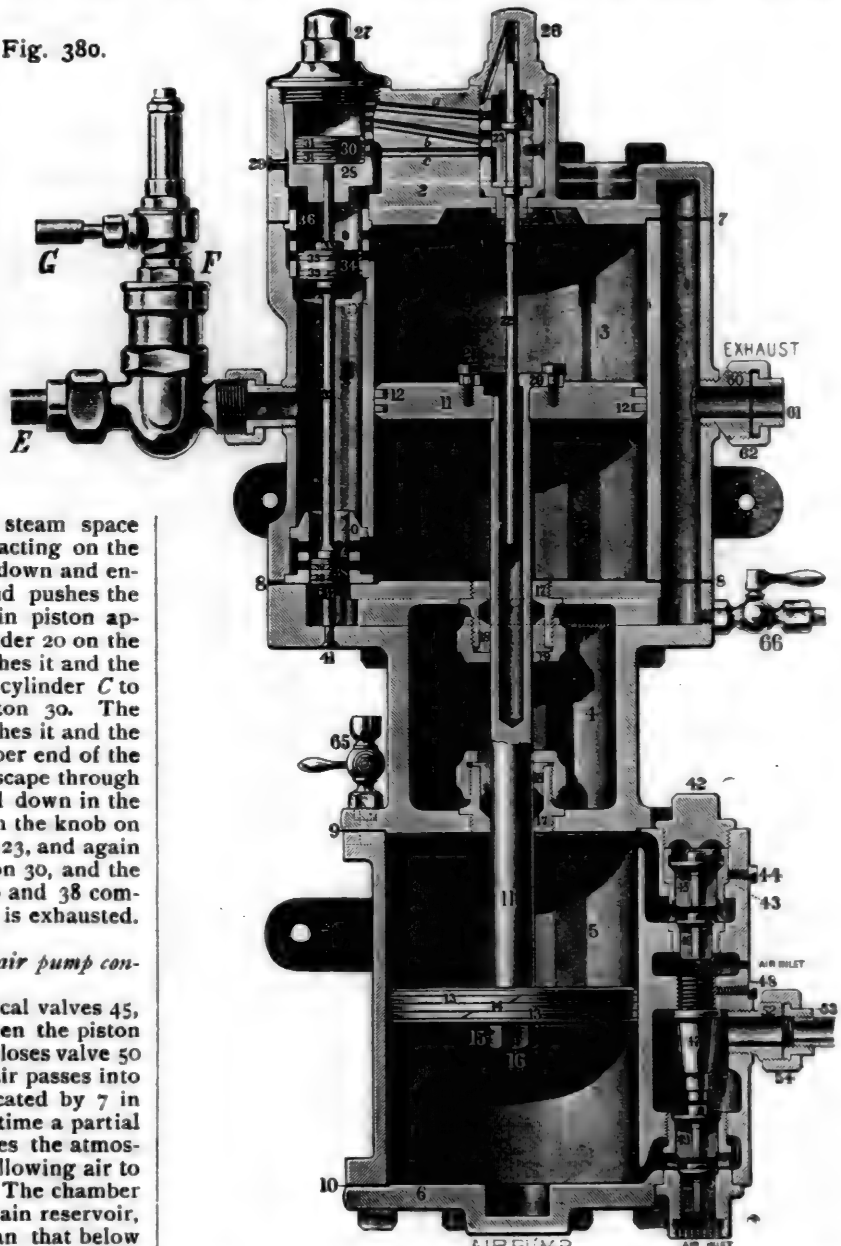
Question 654. *How is the action of the air pump regulated?*

Answer. By means of what is called a pump governor, *F*, shown in fig. 380, on the left-hand side of the pipe connection at *A* and in a vertical section in fig. 381.

Question 655. *What is the construction and action of the pump governor?*

Answer. One end, 23, of the horizontal pipe 2 2 is connected to the boiler and the other end to the pump. The chamber 2 2 has a division and a valve, 9, between the two ends. The valve is connected by a stem, 7, to a piston, 5, which bears on a spiral spring, 8. 19 is a diaphragm which is pressed down by another spiral spring, 18, which resists a pressure under the diaphragm of about 70 lbs. per square inch. A small conical valve, 17, is connected to the diaphragm, and opens and closes an opening below it and above the piston 5. The space below the diaphragm is connected by a pipe, 21, to the brake-pipe. When the air pressure below the diaphragm exceeds 70 lbs. it raises it and opens the valve 17, which admits compressed air above the piston 5, which is forced down, thus closing the valve 9 and shutting off steam from the pump. The air in the pipe 21 then escapes past the piston 5, which fits loosely in its cylinder, and escapes from it into the open air, through an opening represented by dotted lines. When the pressure in the brake-pipe 21 is reduced the spring 18 closes the valve 17, so that the action of the spring

Fig. 380.



8 and the pressure below the valve 9 opens it and admits steam to the pump.

Question 656. *How are the brake-cylinders and pistons constructed?*

Answer. The construction of the brake-cylinders is shown in section by fig. 382. It is a simple cylinder with a piston, 8, which has leather packing, 9, and a piston-rod, 3. The piston-rod, after being driven out by compressed air, is forced back again by a spiral spring, 12, which is wound around the piston-rod.

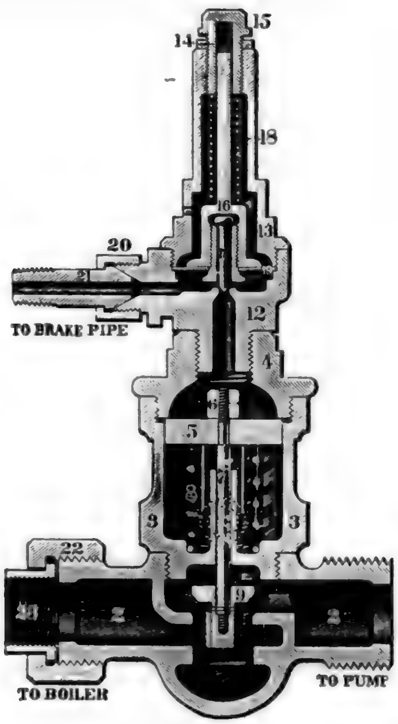
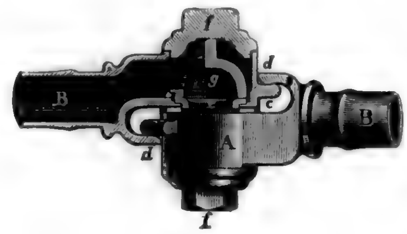


Fig. 381.

Fig. 383.



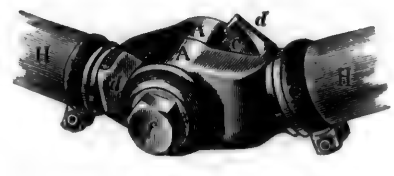


Fig. 384.

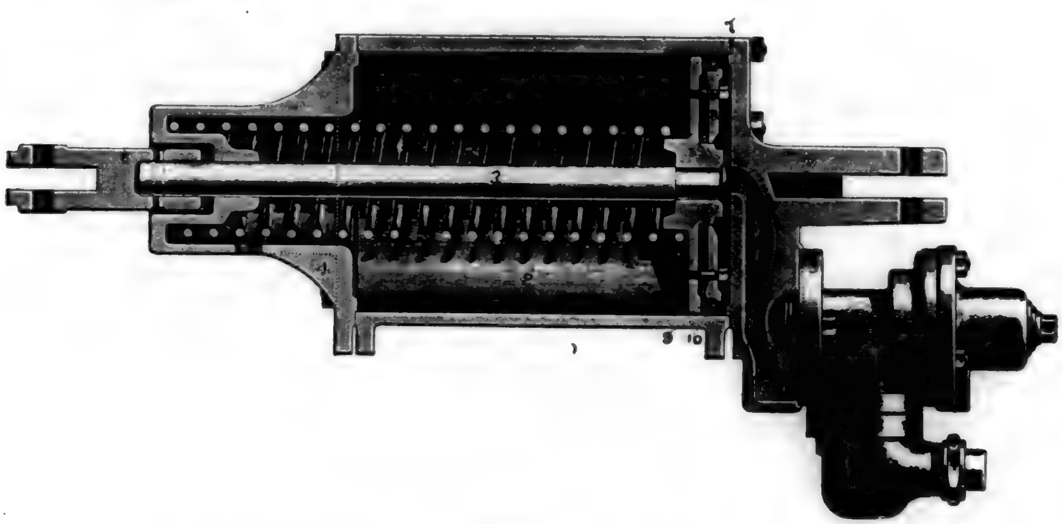


Fig. 382.

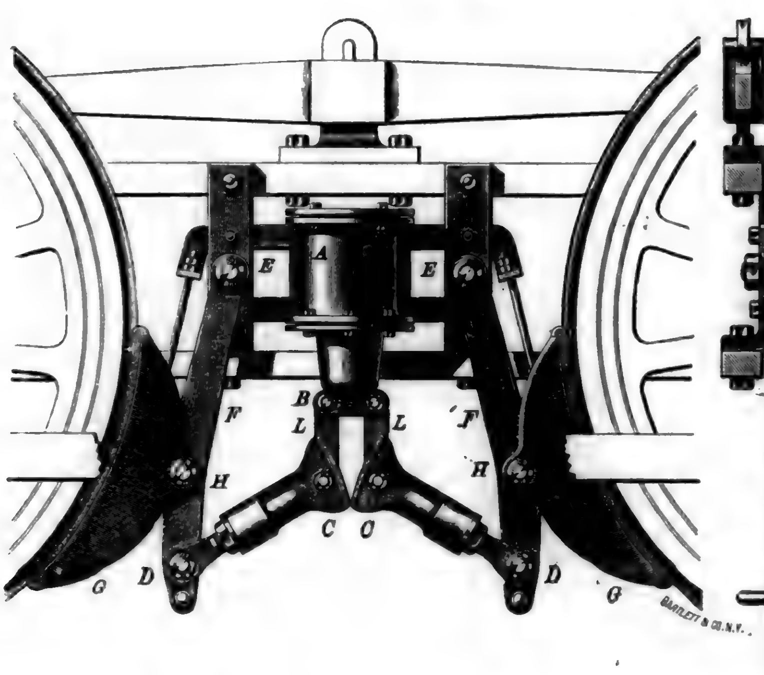


Fig. 385.

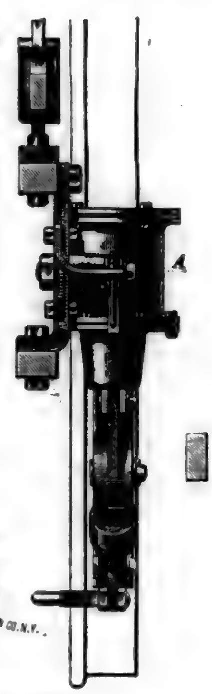


Fig. 386.

To prevent the application of the brakes from a slight reduction of pressure, caused by leakage in the brake-pipe, an oval groove—shown at *b* at the top of the piston in fig. 382—is cut in the body of the brake-cylinder, of such a length that the piston must travel three inches before the groove is covered by the packing leather. A small quantity of air, such as results from a leak, passing from the triple-valve into the cylinder, has the effect of moving the piston slightly forward, but not sufficiently to close the groove. This permits the air to flow out past the piston. If, however, the brakes are applied in the usual manner, the piston will be moved forward beyond the groove, notwithstanding the slight leak.

QUESTION 657. *How are the brake-pipes on the locomotive tender and cars connected together?*

Answer. By flexible hose, 5 5′ 5″, Plate VI, between the different vehicles in the train. The hose are attached at one end to the brake-pipes and are connected together between the different vehicles in the train by couplings, shown by figs. 383 and 384. Cocks 29 29′ 29″, Plate VI, are attached to the ends of the brake-pipes on each car and at the back end of the tender. The end of the pipe which comes at the end of the train can thus be closed to prevent the air in the brake-pipe from escaping.

QUESTION 658. *What arrangement is made for applying the brakes from the inside of the cars?*

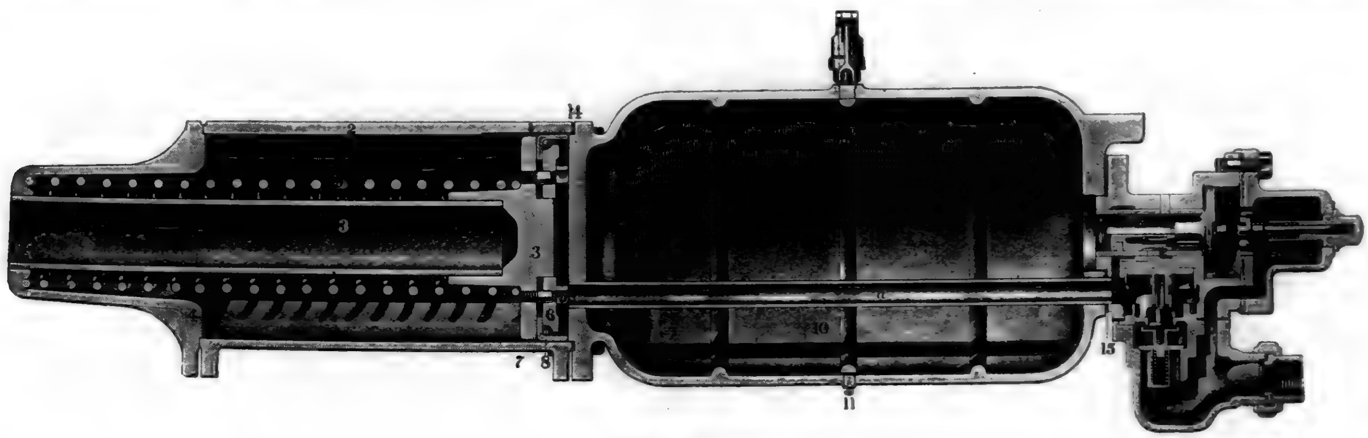


Fig. 391.

Answer. A vertical pipe with a cock or valve, 28″, Plate VI—called a "conductor's valve"—on the upper end is connected to the brake-pipe on each car. By opening this valve the air in the brake-pipe can escape which applies the brakes. A cord which extends the whole length of the car is usually connected to this valve, so that it can be pulled from any part of the car.

QUESTION 659. *How is the moisture which condenses in the inside of the pipes and reservoirs removed?*

Answer. A cup called a drip-cup is connected to the brake-pipes below the tender, from which the water that collects in it is drawn by means of a cock in the bottom of the cup. Cocks are also attached to each reservoir, and when they are opened and if there is any water in the reservoirs it can escape.

QUESTION 660. *How are the air brakes on the locomotive arranged?*

Answer. The brake-shoes are usually applied to the driving-wheels, and are located between these wheels, as shown in Plate VI and fig. 385, which is a side view, and fig. 386 an end view, showing the arrangement of the brakes in relation to the wheels. A brake-cylinder, *A*, is placed on each side of the engine, the piston-rods of which work through the lower head. The rods have cross or T-heads, *B*, on their lower ends, which are connected by links, *L L*, to the cams *C C*. These cams are connected to the levers *F F* at *D D*. The levers have brake-blocks *G G* attached to them by pins at *H H*. The surfaces of the two cams which are in contact with each other are eccentric to the center of the pins *D D*, and when they are pressed down by the piston they force their lower ends *D D* and levers *F F* outward, which presses the brake-blocks against the wheels. 6, Plate VI, is the auxiliary reservoir for the engine or "*driver-brakes*," as they are called, and 12 is the triple-valve by which the brake on the engine is operated. 11 is the pipe which supplies the driver-brake reservoir with compressed air, and 10 is the pipe by which it is conveyed from the triple-valve to the brake-cylinders.

QUESTION 661. *What is meant by the term "Straight Air Brake?"*

Answer. As explained in answer to question 634, this term is used to designate the first form of the Westinghouse Air Brake, in which there were no auxiliary reservoirs under the cars, the compressed air being stored in a main reservoir on the engine or tender, from which it flowed direct through the brake-pipe to the brake-cylinders under the different vehicles. The brakes were released when communication was closed between the main reservoir and the brake-pipe, and opened from the brake-pipe to the atmosphere by means of the engineer's valve. When "straight air" is applied it flows direct through the brake-pipe to the brake-cylinders, and the auxiliary reservoirs, triple-valves, and pressure-retaining valves are not used, and the brake has no automatic action.

QUESTION 662. *How can the Automatic Brake be used as a Straight Air Brake?*

Answer. The old form of Automatic Brake can be converted into a Straight Air Brake by simply turning the handle *K*, fig. 369, of the four-way cock on the triple valve downward to *M*, so as to stand in a vertical (|) position; the cock then opens direct communication from the brake-pipe to the brake-cylinders through the channels *a e d*. With the new quick-acting triple-valve, which will be described further on, the Automatic Brake cannot be converted into a Straight Air Brake.

QUESTION 663. *When should the Automatic Brake be used as a Straight Air Brake?*

Answer. In case of serious leakage of pipes, or other defect which prevents the use of the automatic brake, the handle of the four-way cocks of all the triple-valves, excepting those on vehicles on which the brakes are cut out, should be turned downward, and the train can then be run with "straight air" to the terminus. It is better to do this than to depend upon the use of the hand-brakes; but all the brakes which are in use (that is, that are not cut out) on a train must be operated either by "straight air" or automatically, as the two systems will not work together on the same train.

QUESTION 664. *How do the air brakes for freight trains operate, and how are they constructed?*

Answer. The action of brakes on freight trains is the same as on passenger trains, although the form of construction is somewhat different. Fig. 387 is a side elevation, and fig. 388 an inverted plan of a freight car with brake attached, and fig. 391 is a section of the cylinder and auxiliary reservoir. The con-

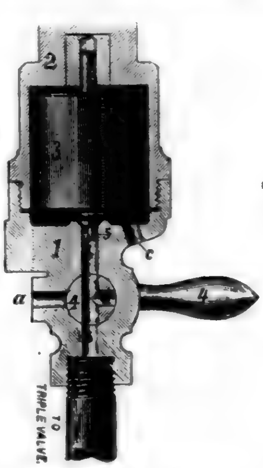


Fig. 392.

struction of the cylinder is substantially the same as that used on passenger trains. The auxiliary reservoir is, however, made of cast iron, and is attached to the brake-cylinder head, as shown in fig. 391.

QUESTION 665. *What provision is made on freight train brakes for descending long grades?*

Answer. What is called a "*pressure-retaining valve*," 40, fig.

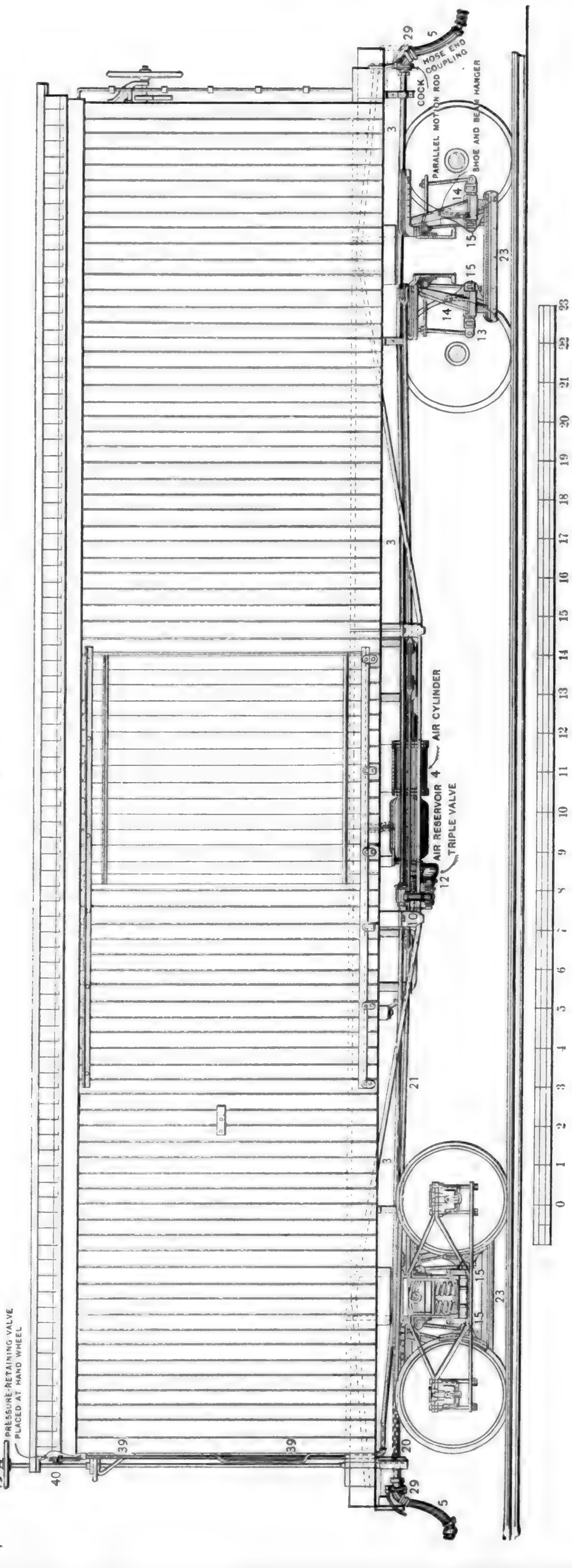


Fig. 387.

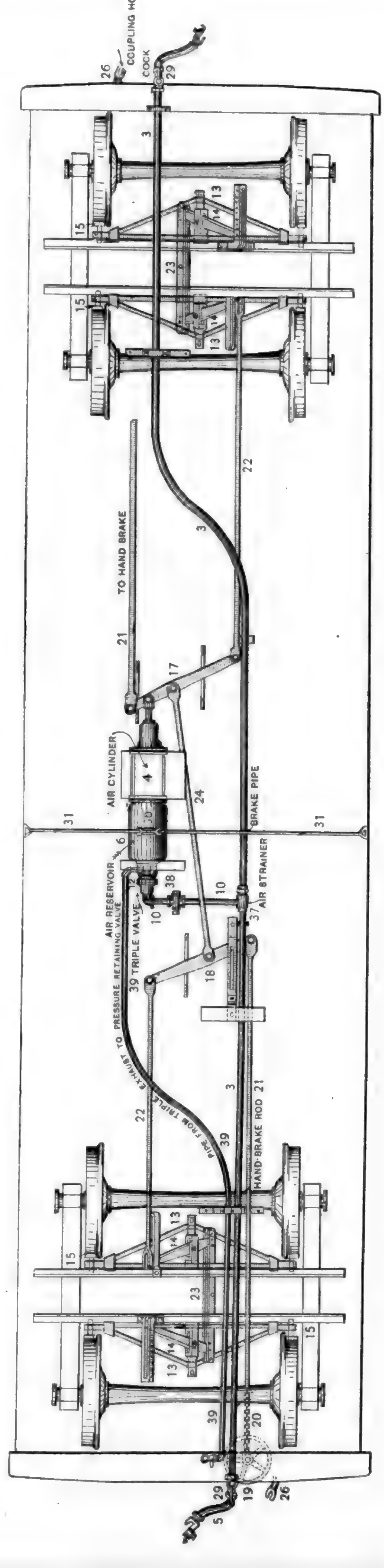
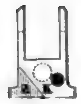


Fig. 388.

Fig. 394.



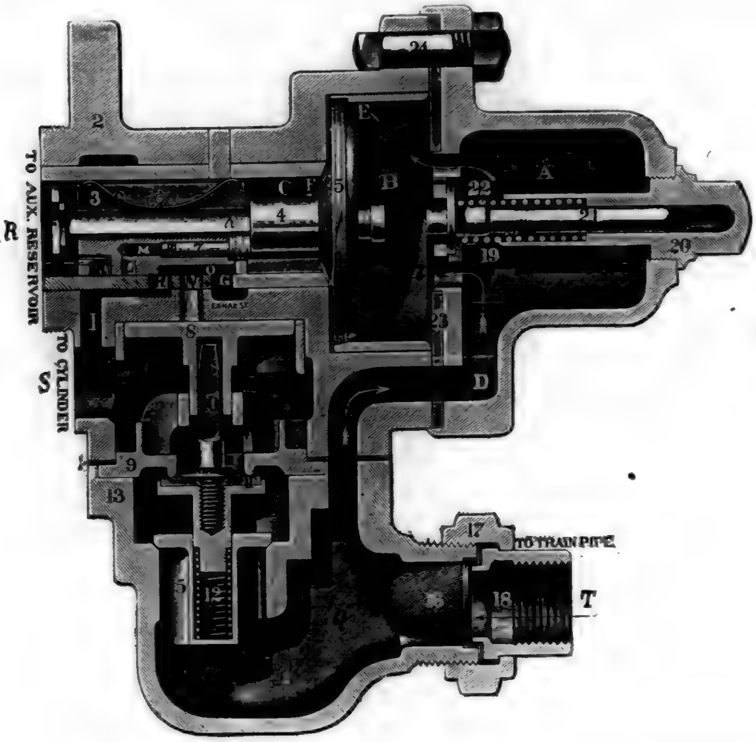


Fig. 393.

Fig. 395.

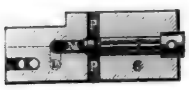


Fig. 396.

Fig. 397.

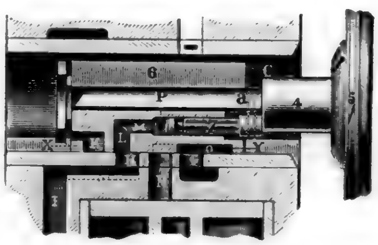


Fig. 398.

Fig. 399.

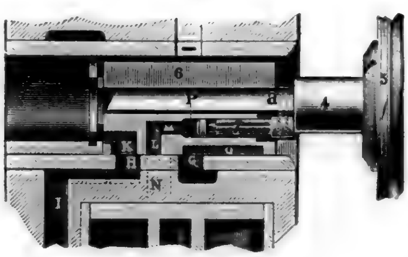
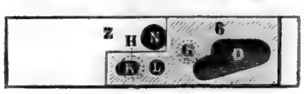


Fig. 400.



387, is connected by a pipe, 39 39, with the discharge port of the triple-valve 12. An enlarged section of this valve is shown by fig. 392. 5 is the valve which opens and closes the passage or pipe *b b*. The valve has a weight, 3, which presses it down. A pressure of about 15 lbs. in the pipe *b b* is sufficient to raise this weight and allow the air to escape at the opening *c*. 4 4 is a three-way cock which, in the position shown—with the handle horizontal—closes the opening *a*, so that the air can escape only under the valve 5 and opening *c*. As the valve is weighted no air can escape until its pressure is sufficient to raise the weight 3. Consequently, if the handle of the cock is turned to a horizontal position in descending long grades, a pressure of about 15 lbs. is retained in the brake-cylinder, which keeps the train under control when otherwise the brakes would be released to recharge the reservoirs. On slight grades or a level the handle of the cock should be turned down, which opens communication between the pipe *b* and opening *a*, which allows the air to escape freely from the discharge port *a* of the pressure-retaining valve.

QUESTION 666. *What difficulty was encountered in operating air brakes on long freight trains?*

Answer. In some tests made with long freight trains it was found that the triple-valve, which has been described, in answer to question 643, would not apply the brakes as quickly as was considered desirable. For that reason the quick-acting triple-valve represented in section by fig. 393 was designed by Mr. Westinghouse.

QUESTION 667. *How is this valve constructed and how does it act?*

*Answer.** The outside shell or casing of this valve has three openings, *R*, *S*, and *T*. *R* is connected to the auxiliary reservoir, *S* to the brake-cylinder, and *T* to the brake-pipe. The latter branch communicates by means of the passages *Q D D′* and openings *l l* with a cylinder, *B*, in which the triple-valve piston 5 works. The chamber *C* on the opposite side of this piston contains a slide-valve, 6, and is in direct connection with the auxiliary reservoir through the branch *R*, and when the piston is in the position shown in the engraving, compressed air from the train-pipe *T* can flow through the channels *Q D D′ l* and through a groove *E* in the cylinder past the piston 5 until the pressure in *C* and in the auxiliary reservoir is equal to that in the train-pipe. At the same time the branch *S* and the brake-cylinder are connected to the atmosphere through the passage *I*, the port *H*, the cavity *O*, in the slide-valve 6, and the port *G* which emerges into the open air. If now the pressure in the train-pipe is slightly reduced by opening the engineer's valve, the pressure in the cylinder *B* will also be reduced, and the piston 5 will be moved to the right, as shown in fig. 397,† by the expansion of the air in the auxiliary reservoir. Under ordinary circumstances, however, the piston will be moved through only half of its available travel, in consequence of the pressure in the reservoir being reduced to that in the train-pipe by a part of the air flowing into the brake-cylinder in the following way: The stem 4 of the piston passes through the slide-valve 6—the connection between the two being so made that the piston can move a small distance without moving the valve. The slide-valve contains a small conical valve, 7, called a "graduating valve," which is seated in a cavity in the valve, and is shown in figs. 393, 397, and also in the

* Much of the following description was taken from one which originally appeared in *Engineering*.

† In drawing the sections of the valve and its seat, some liberty has been exercised in order to show how the valve acts. The sections are not strictly correct, but they thus show the operation of the valve more plainly than they would if they represented the valve exactly.

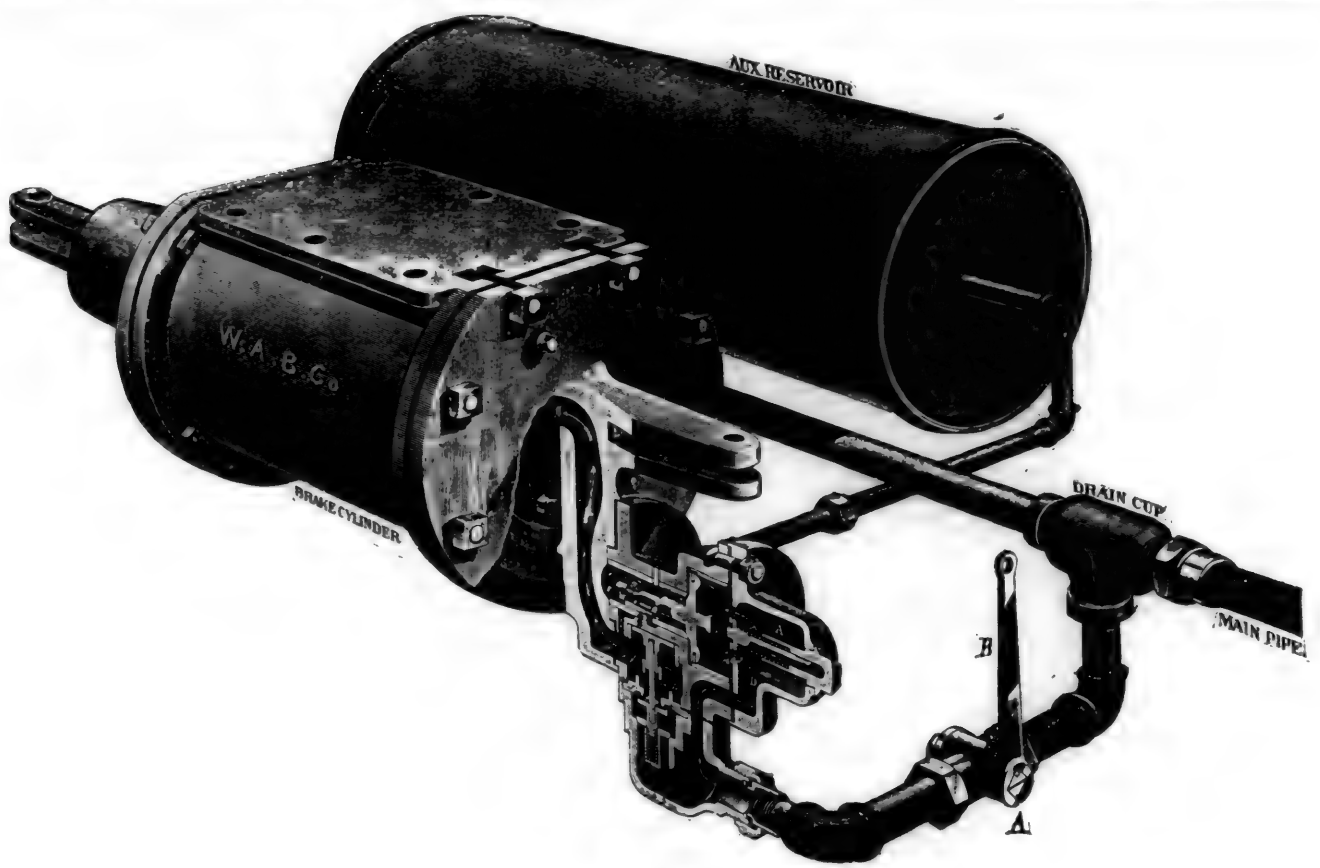


Fig. 401.

horizontal section, fig. 395, which is drawn through the center of the valve. This conical valve is connected to the slide-valve by a pin, *a*, so that when the piston first moves, it carries with it and opens the valve 7. This allows air which enters through the passages *P P* to flow into the passage *M*. The continued movement of the piston carries the slide-valve 6 to the right, as shown in fig. 397 and also in fig. 398, which repre

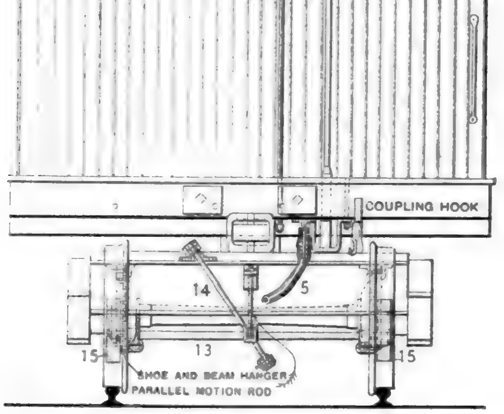


Fig. 389.

sents a plan of the valve face with a horizontal section of the valve drawn on the line *X Y* of fig. 397. This movement of the valve first closes the connection of the port *H* with the atmosphere through the cavity *O*, and then brings the port *L* in the valve over the port *H* in the valve-seat. The air can then flow from the chamber *C* and auxiliary reservoir through the openings *P*, passage *M*, port *L*, port *H*, and passages *I* and *S* into the brake-cylinder, and it thus applies the brakes. As soon as the pressure in *C* has fallen slightly below that in the brake-pipe, the pressure on the opposite side *B* of the piston 5 moves the latter slightly back and closes the valve 7, and cuts off the air supply to the brake-cylinder. If now the pressure in the train-pipe be again slightly reduced by the engineer's valve, the valve 7 will again be opened by the piston 5, and in this way by repeated applications the brakes can be applied gradually up to the maximum force which would be possible when the pressure is equalized in the cylinders and auxiliary reservoirs.

QUESTION 668. *How does the triple-valve, shown in fig. 393, act in making an emergency stop in case of danger?*

Answer. If the locomotive runner opens his valve wide the pressure in the brake-pipe will be so far reduced that the piston 5 will move to the extreme limit of its travel, and will seat itself against the leather ring 23. This opens the valve 7 and moves

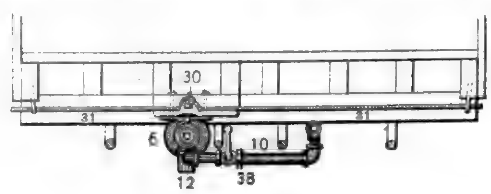


Fig. 390.

the slide-valve 6 to the position shown in fig. 399 and fig. 400, and brings the port *K* over *H*.

From the end view, fig. 394, and sectional plan, fig. 400, of the slide-valve 6, it will be seen that one corner of it at *Z* is cut away diagonally. Consequently, when the valve gets into the position shown in figs. 399 and 400 it uncovers the port *N*. Air from the auxiliary reservoir then flows through the passage *N* and acts on the piston 8, forcing it down, which opens the valve 11, fig. 393. As soon as this occurs the pressure in the chamber *Q* and train-pipe *T*, below the check-valve 15, raises it, and there is then a clear passage from the train-pipe through the pipe *S* into the brake-cylinder. There is also a passage from the auxiliary reservoir through the port *K*, fig. 399, and passage *I* into the brake-cylinder, but as the area of the cross sections of these passages, compared with that through the valves 11 and 15, is relatively small, the air in the train-pipe has time to discharge into the brake-cylinder before the pressure in the latter has been increased much by that which enters from the reservoir through *K* and *I*. The air in the brake-pipe has thus time to discharge into the cylinder and thus relieve the pressure in

Fig. 402.

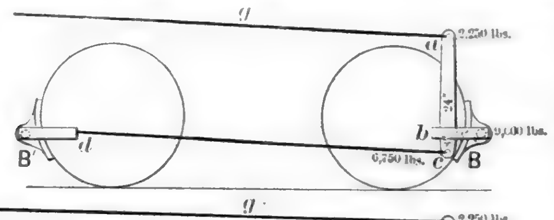


Fig. 403.

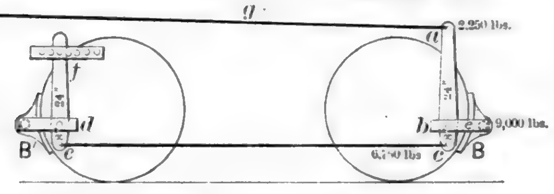


Fig. 404.

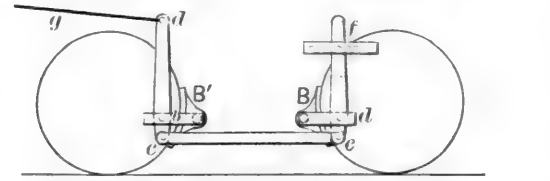
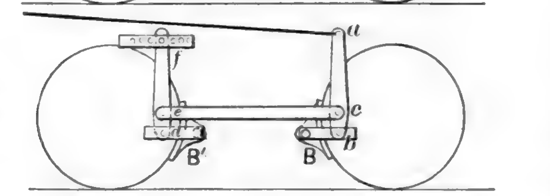


Fig. 405.



the pipe *before* the air from the auxiliary reservoir has increased the pressure above the check-valve 15 sufficiently to close it, thus preventing the air above it from flowing back into the brake-pipe. By this means the air in the brake-pipe under each vehicle is discharged into the brake-cylinder, thus utilizing it for applying the brakes and effecting a quicker discharge and more prompt application of the brakes than is possible if the air in the brake-pipe must all escape through the engineer's valve.

After the engineer has accomplished his object, the brakes are released in the usual way, by opening communication between

QUESTION 669. *How is the quick-acting triple-valve applied to the brake-cylinders?*

Answer. On passenger trains it is attached to the end of the brake-cylinder as shown in fig. 401, which is a perspective view of a brake-cylinder, auxiliary reservoir, and triple-valve—the latter shown in section—with their connections. On freight trains the auxiliary reservoir is attached to the brake-cylinder head, and the triple-valve is bolted to the end of the reservoir with a pipe, *a*, running through the latter, as shown in fig. 391, which represents a section of these parts.

QUESTION 670. *With how much force should the brake-blocks be pressed against the wheels?*

Answer. The friction between the brake-blocks and the wheels, and between the wheels and the rails, or the "adhesion" of the wheels, is very nearly the same with equal pressures. Therefore, if the force with which the brakes are pressed against any of the wheels should be greater than the weight on the rails under those wheels, the friction of the brake-blocks would exceed the adhesion of the wheels to the rails, and the wheels would slide. For this reason the pressure of the brakes on any pair of wheels should never exceed the weight on the rails under those wheels. Experience has shown that the wheels of passenger cars are liable to slide if the brake pressure on any of the wheels exceeds 90 per cent. of the weight on the rails under them, and if they do slide they are liable to have flat spots worn on the treads. For this reason the pressure of the brake on any wheel of a passenger car is limited to 90 per cent. of the weight on the rail under it when the car is empty or light, and the pressure on freight cars is limited to 70 per cent. of the light weight.

QUESTION 671. *How is the pressure applied to the brake-shoes?*

Answer. By means of levers connected to the brake-beams to which the brake-shoes are attached.

QUESTION 672. *How are the brake-levers arranged in relation to the wheels?*

Answer. The levers which are connected to the brake-beams are arranged in several different ways. Fig. 402 shows the simplest arrangement in use for hand-brakes, with the brake-blocks *B B* outside of the wheels. It consists of a single lever, *a b c*, which is connected to the brake-beam *e* by a fulcrum, *b*. The lower end *c* of the lever is connected by a rod, *c d*, to the brake-beam *d*. The upper end *a* of the lever is connected by a rod, *g*, to the brake-windlass. This arrangement is open to the objection that the pressure on the brake-beam *B* is greater than that on *B′*, and therefore this plan is now seldom used.

Fig. 403 represents an arrangement with double levers which

STEVENS SYSTEM.

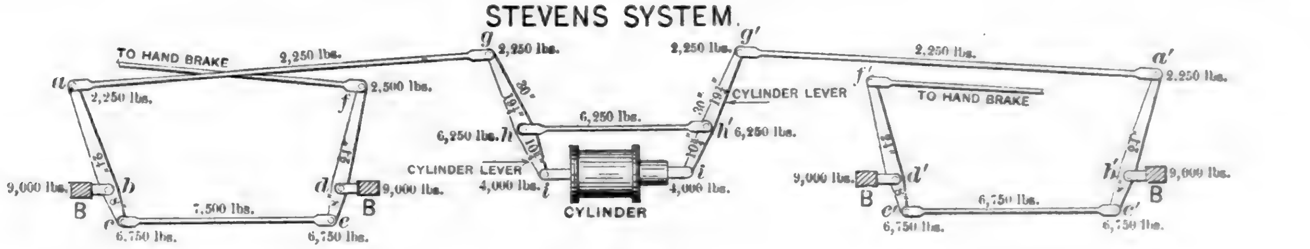


Fig. 406.

HODGE SYSTEM.

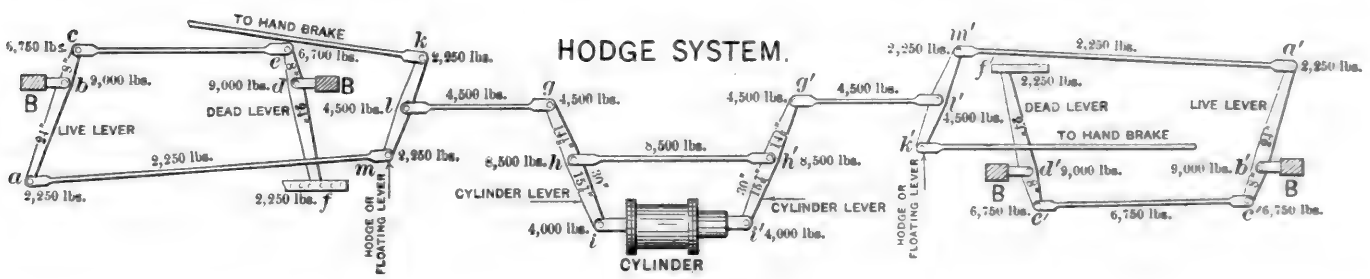


Fig. 407.

the main reservoir and the brake-pipe through the engineer's valve on the engine. The pressure in the train-pipe *T* then flows through the passages *Q D l l* and moves the piston 5 back into the position shown in fig. 393. The cavity *O* in the valve then connects the passage *N* with the atmosphere, which relieves the pressure above the piston 8, which is raised by the pressure under it, and the valve 11 is closed by the spring 12 below it. The air in the brake-cylinder then exhausts through the passage *I*, port *H*, cavity *O* in the valve and passage *G* into the open air, and the springs in the brake-cylinder return the brake-pistons and take off the brake-blocks from the wheels, and the auxiliary reservoirs are again recharged through the groove *E*.

are attached to the brake-beams in the same way as the lever *a b c* shown in fig. 402. The brake-blocks are also outside of the wheels, and the lower ends of the levers are connected together by a rod, *c e*. The upper end of the lever *e d f* is held by an adjustable stop at *f*. With this arrangement, the rod *c e* is in tension when the brakes are applied by the brake-windlass.

Fig. 404 represents an arrangement with two levers and the brake-blocks *B B′* between the wheels. The upper end *a* of the lever *a b c* is connected to the brake-windlass, and *f d e* is held by an adjustable stop *f*. The rod *c e* is in compression when the brakes are applied.

Fig. 405 shows another arrangement similar to fig. 404, excepting that the rod *c e* is above instead of below the brake-beams.

QUESTION 673. *How are the air brake cylinders connected to the brake-levers?*

Answer. Two systems, the Stevens and the Hodge, shown by figs. 406 and 407, are used. The brake cylinders are usually placed between the two trucks and have two levers, *g i* and *g' i'*: one of these, *g' i'*, is connected to the brake-piston at *i'*, and the other, *g i*, to the brake-cylinder at *i*. They are connected to-

Fig. 408.

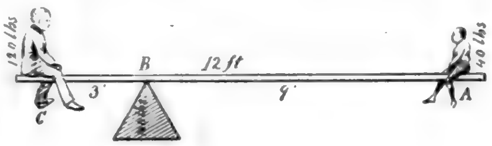


Fig. 409.

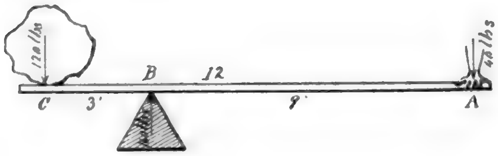


Fig. 410.

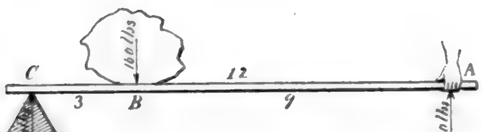
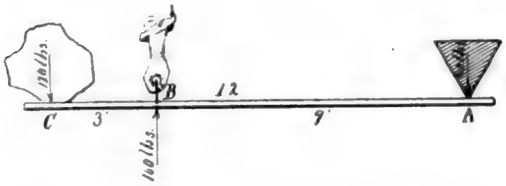


Fig. 411.



gether by a tie-rod, *h h'*, and in the Hodge brake by rods *g l* and *g' l'* to the floating levers *k m* and *k' m'*. In the Stevens system the cylinder levers are connected directly to the brake-beam levers *a c* and *a' c'*. With this arrangement, it is only necessary to give the levers the right proportion to get the proper pressure of the brakes on the wheels.

QUESTION 674. *How can the pressure which should be exerted by the brake-shoes on the wheels be calculated?*

Answer. The first thing to do is to ascertain the minimum weight on the rails under each pair of wheels of the car or other vehicle to which the brakes are applied. This is done by taking the total weight of the car when empty and dividing it by the number of its pairs of wheels. Then for passenger cars take 90 per cent. and in the case of freight cars 70 per cent. of the weight on each pair of wheels, which will be the pressure which should be exerted on each brake-beam.

Thus suppose we have an eight-wheeled passenger car which weighs 40,000 lbs. empty. It would have 10,000 lbs. of weight to each pair of wheels, 90 per cent. of which would be 9,000 lbs., which is the pressure that should be exerted on each brake-beam.

In the case of six-wheeled trucks on which the brakes are not usually applied to the middle pair of wheels, the calculation is made in the same way, the only difference being that the brakes are omitted on the middle pair of wheels.

QUESTION 675. *What should be the pressure in the brake-cylinders?*

Answer. Experience has shown that a pressure of 50 lbs. per square inch in the cylinders of the old automatic and 60 lbs. with the new quick-acting brake is the best that can be used. The size of the cylinders and the brake-levers should then be so proportioned that this air pressure will exert the required force on the brake-beams.

QUESTION 676. *How can the proportion of the brake-levers be calculated?*

Answer. Their proportions are calculated from the well-known principle of the lever.

QUESTION 677. *How may the principle of the lever be explained?*

Answer. Every boy has learned that if the middle of a board rests on a fence-rail or other support that two boys, of equal weight, will balance each other, if one of them sits on one end of the board and one on the other end. If it is 12 ft. long, and is moved so that the support is 4 ft. from one end and 8 ft. from the other, then the boy who sits on the short end must be twice as heavy as the one on the long end to balance each other. If the support is 3 ft. from one end and 9 ft. from the other, as in fig. 408, then the heavy boy must be three times the weight of the small one. That is, if the small boy weighs 40 lbs. the big one must weigh 120 lbs. It is also obvious that the weight of both boys is sustained by the support *B*, and therefore the load on it is equal to $40 + 120 = 160$, leaving out the weight of the board. It will also be noticed that the weight of both boys bears downward on the board, and if the edge of the support *B* was sharp and hard, and the board soft, that an indentation in it would be made where it rests on the support *C*, showing that the pressure against the board at this point is upward.

The same principle would be illustrated if the board was used as a lever to lift a heavy stone or other object, as shown in fig. 409. In this case if the stone weighed 120 lbs. and the two arms of the lever were the same length as before, it would require a pressure of 40 lbs. at *A* to balance or raise the stone at *C*, and the support or *fulcrum*, as it is called, at *B* would sustain a pressure of 160 lbs. In this case, too, the forces at *A* and *C'* both act downward and the pressure of *B* is upward against the board, as indicated by the arrows.

If we place the support at *C*, as in fig. 410, and the stone at *B*, then an upward force of 40 lbs. exerted at *A* will raise a stone of 160 lbs. weight at *B*. In this case the two forces at *A* and *C* both act upward, and that at *B* downward, as indicated by the arrows.

If the support or fulcrum against which the board bears is placed above it at *A*, and if the stone is at the end *C*, as shown in fig. 411, and a person should take hold of the board at *B*, then it would require an upward pull of 160 lbs. at *B* to raise the stone, and the forces would act in the direction indicated by the arrows.

From these illustrations it will be seen that in each case when the levers are in equilibrium or are balanced, *there are two forces which act in one direction against the ends of the lever, and one force which acts in the opposite direction between them*, and that *the two end forces added together or their sum is equal to the third force acting in the opposite direction.* This is true not only of the cases illustrated, but it is true *of all levers* on which the forces act in directions parallel to each other, which are the only kind which need be considered here. The greater of the two forces which act in the same direction on the short end of the lever will be called the *major-force*, the smaller one, which acts on the long end of the lever, the *minor-force*, and that acting in the opposite direction between the two ends the *counter-force.* The major-force is always at the short end of the lever, and the minor-force at the long end. If the two arms of the lever are of equal length, the major and minor-forces will also

Fig. 412.

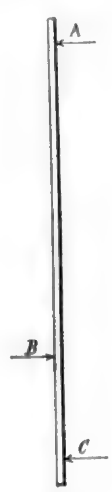


Fig. 413.

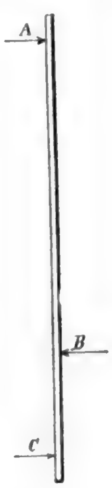


Fig. 414.

be equal. If *the major-force is multiplied by the length of the short arm of the lever, the product will always be equal to that of the minor-force multiplied by the length of the long end of the lever.* That is, in fig. 408 the weight of the major boy, $C = 120$ lbs., multiplied by 3 ft., the length of the short end $C\ B$, $= 360$, and the weight of the minor boy, $A = 40$ lbs. $\times$ 9 ft., the length of the long end $A\ B = 360$.

It does not make any difference either in what direction these forces act. The effect of the in-action will be the same, if instead of being horizontal the levers stood upright or vertical, as shown in figs. 412–414, in which the direction of the

forces is indicated by darts and their magnitude by figures. These figures show, too, that the action of the forces in figs. 412 and 414 is exactly the same, and that the only difference between them and fig. 413 is that the forces in the two cases act in opposite directions.

QUESTION 678. *How can we know which is the major, which the minor, and which the counter force acting on a lever?*

Answer. This can always be known with certainty if it is remembered that the major and minor-forces always act on the ends of the lever and in an opposite direction to the counter-force* which is between them, and that the major-force is always at the short end of the lever and the minor one at the long end.

QUESTION 679. *If we have the length of the two ends of a lever and either the major or the minor-force, how can we calculate the other?*

Answer. MULTIPLY THE KNOWN FORCE BY THE LENGTH OF ITS END OF THE LEVER AND DIVIDE THE PRODUCT BY THE LENGTH OF THE OPPOSITE END. The quotient will be the required force. Thus: supposing that in fig. 408 we have the weight of the small boy, 40 lbs., and the length of the two ends of the lever as 9 and 3 ft. respectively, then $40 \times 9 \div 3 = 120$ = the major-force *C*.

QUESTION 680. *If we have the length of the two ends of a lever and either the major or the minor-force, how can we calculate the counter-force?*

Answer. ADD THE LENGTH OF THE TWO ENDS OF THE LEVER TOGETHER TO GET ITS WHOLE LENGTH; THEN MULTIPLY THE KNOWN FORCE BY THE WHOLE LENGTH AND DIVIDE BY THE OPPOSITE END OF THE LEVER. Thus in fig. 408, knowing the weight of the small boy at *A*, and the length of the two ends of the lever being 3 and 9 ft., then $3 + 9 = 12 \times 40 \div = 160$ = counter-force at *B*.

QUESTION 681. *If we have the counter-force and the length of the two ends of the lever, how can we calculate the major and minor-forces?*

Answer. TO GET THE MAJOR-FORCE, MULTIPLY THE COUNTER-FORCE BY THE LENGTH OF THE LONG END OF THE LEVER AND DIVIDE BY ITS WHOLE LENGTH; TO GET THE MINOR-FORCE, MULTIPLY THE COUNTER-FORCE BY THE LENGTH OF THE SHORT END OF THE LEVER AND DIVIDE BY ITS WHOLE LENGTH. Thus if in fig. 409 we have *B*, the counter-force equal to 160 lbs., and the two arms of the lever 3 and 9 ft. respectively, then $160 \times 9 \div 12 = 120$ = major-force, or $160 \times 3 \div 12 = 40$ = minor-force.

QUESTION 682. *Having the major and minor-forces which are exerted at the ends of a lever, and its whole length, how can we calculate the length of its two ends?*

Answer. FIRST ADD THE MAJOR AND MINOR-FORCES TOGETHER, WHICH WILL GIVE THE COUNTER FORCE; THEN TO GET THE LENGTH OF THE LONG END OF THE LEVER MULTIPLY THE MAJOR-FORCE BY THE WHOLE LENGTH AND DIVIDE BY THE COUNTER-FORCE. TO GET THE LENGTH OF THE SHORT END, MULTIPLY THE MINOR-FORCE BY THE WHOLE LENGTH AND DIVIDE BY THE COUNTER-FORCE. OR IF WE HAVE THE LENGTH OF ONE END WE CAN GET THAT OF THE OTHER BY DEDUCTING THE LENGTH OF THE ONE FROM THE WHOLE LENGTH.

Thus supposing that in fig. 409 the major and minor-forces *A* and *C* are equal to 120 and 40 lbs. respectively, and the whole length of the lever 12 ft., then $120 + 40 = 160$ = counter-force, and $120 \times 12 \div 160 = 9$ = length of long end of lever, and $40 \times 12 \div 160 = 3$ = length of short end of lever.

QUESTION 683. *How can the proportions of the brake-beam levers and the pressures exerted by them be calculated from the preceding rules?*

Answer. To illustrate how this can be done, the arrangement of lever shown in fig. 402 will be taken first. It will be supposed that the pressure on the brake-shoe is to be 9,000 lbs., and that the lower end of the lever is 8 and the upper one 24 in. long; what force must be exerted at *a*? In this case the pressure on the brake-shoe is the counter-force, and that at *a* the minor-force; by the rule given in answer to question 681, we will have $9{,}000 \times 8 \div 32 = 2{,}250$ lbs. = the force which must be exerted at *a*. To get the major-force exerted at *c* on the rod *c d* and brake-shoe *B'* we have $9{,}000 \times 24 \div 32 = 6{,}750$. This explains what has already been pointed out, that with this arrangement of brakes the pressure on the shoe *B'* is less than that on *B*.

If we want to calculate the pressure which a force at *a* of 2,250 lbs. would exert on the brake-shoe, by the rule in answer to question 680, we will have $24 + 8 = 32 \times 2{,}250 \div 8 = 9{,}000$ = pressure on *B*.

The calculations are similar for the leverages in figs. 403, 404 and 405. In fig. 403, with a force of 2,250 lbs. at *a* we would again have 9 000 at *b* and 6,750 at *c*, and as this is exerted on the rod *c e*, it would be the major-force acting on the lever *f d e*. To get the pressure exerted on the brake-shoe *B'* by the rule, in answer to question 680, we would have $8 + 24 = 32 \times 6{,}750 \div 24 = 9{,}000$ lbs., showing that with this arrangement of levers the pressure on the two brake-shoes is equal.

It happens in applying air-brakes to cars that the proportions of the brake-beam levers *a b c* and *f d e*, figs. 406 and 407, are nearly always established; therefore the problem usually is to proportion the cylinder-levers *g h i* and *g' h' i'* to produce a given pressure on the brake-beams with some given dimensions of brake-beam levers.

QUESTION 684. *How are the proportions of the cylinder-levers calculated?*

Answer. As an example, we will take the dimensions and pressures referred to in the answer to the previous question, and represented in fig. 403. With the proportions of levers given to exert a force of 9,000 lbs. on the brake-beams, there must be a pull of 2,250 lbs. on the rods *a g* and *a' g'*, fig. 406. These rods are connected to the cylinder-levers *g h i* and *g' h' i'*. One of these levers is connected to the cylinder at *i* and the other to the piston-rod at *i'*, and they are connected together by the rod *h h'*. Consequently, when the piston-rod is forced out it exerts a pull on the rods *h h'*, *g a*, and *g' a'*, which is communicated to the levers *a b c* and *a' b' c'*. If the cylinder is 10 in. in diameter—a usual size—the area of its piston will be 78.5 square in., which multiplied by a pressure of 50 lbs. per square in. will give a total pressure on the piston of 3,925 lbs., which for even figures will be taken at 4,000 lbs. The total length of the cylinder-levers *g h i* and *g' h' i'* will be assumed to be 30 in., and it has been shown that a pull of 2,250 lbs. is required on the rods *a g* and *g' a'* to produce the required pressure on the brake-beams. The problem then is to determine the length of the two ends of the cylinder-levers so that a pressure of 4,000 lbs. exerted by the piston at *i'* will pull with a force of 2,250 lbs. at *g* and *g'*. We have the major and the minor-forces and the total length of the lever, so that by the rule in answer to question 682 we would have $2{,}250 + 4{,}000 = 6{,}250$ = the counter-force at *h* and *h'*. $4{,}000 \times 30 \div 6{,}250 = 19.2$ in. = long end of lever. The length of the short end of the lever is, of course, equal to its whole length less the length of the long end, or $30 - 19.2 = 10.8$ in.

Some care should be taken not to get the position of the ends of these levers reversed from what they should be. *The short end should always be next to the major-force and the long end next to the minor-force.*

QUESTION 685. *What different arrangement of levers is used in applying the air-brake?*

Answer. As explained in answer to question 673. Two systems are commonly used, the one known as the Stevens system, fig. 406, and the Hodge system, shown in fig. 407. In the latter what are called floating-levers, *k l m* and *k' l' m'*, are used. One end, *m* and *m'*, of each of these levers is connected to the brake-beam lever *a b c* and *a' b' c'* by rods *m a* and *m' a'*; the other ends of the floating-levers are connected to the hand-brakes, and the cylinder-levers are connected to the middle of the floating-levers by rods *g l* and *g' l'*. It is obvious that with this arrangement, if the two ends of the floating-levers are of equal length, one-half of the pull which is exerted by the cylinder-levers, through the rods *g l* and *g' l'*, is transmitted to the hand-brakes, and the other half to the levers *a b c* and *a' b' c'*. Consequently, with this arrangement the cylinder-levers must be so proportioned that they will exert a pull through the rods *g l* and *g' l'* equal to double that which must act on the ends *a* and *a'* of the "live" brake-beam levers *a b c* and *a' b' c'*. In this case, then, the levers must be proportioned so that a pressure of 4,000 lbs. on the piston at *i* will exert a force of 4,500 lbs. at *g* and *g'*. The calculation for the length of the long end of the lever would therefore be $4{,}500 + 4{,}000 = 8{,}500$ = the counter-force at *h* and *h'*. $4{,}500 \times 30 \div 8{,}500 = 15\frac{7}{8}$ = long end of lever. It will be noticed that in figs. 406 and 407 the relative position of the long and short ends of the cylinder-levers is reversed; in fig. 406 the short end is next to the cylinder, whereas in fig. 407 the long end is in that position.

The force exerted on the rod *h h'*, fig. 407, will be equal to the counter-force, or $4{,}000 + 4{,}500 = 8{,}500$ lbs. By calculating the effect of this, it will be found that the same force is exerted on the rods *g l* and *g' l'*, showing that the brakes are applied equally on both trucks.

QUESTION 686. *How may the rules for calculating the length of brake-levers be summarized?*

Answer. The following are the essential rules to be used for such calculations:

I. *To get the pressure on the brake-piston:* MULTIPLY THE AREA OF THE BRAKE-PISTON IN SQUARE INCHES BY THE AIR PRESSURE PER SQUARE INCH, IN LBS., IN THE CYLINDER (usually 50 lbs.).

II. *To get the pressure on each brake-beam:* FOR PASSENGER

* The direction in which a force acts on a lever can always be known by observing which side of the lever would be indented if it was made of soft material and the force was exerted against it by a sharp object.

CARS TAKE 90 PER CENT. OF THE WEIGHT (when empty), IN LBS., ON THE RAILS BELOW THE WHEELS TO WHICH THE BRAKES ARE APPLIED AND DIVIDE BY THE NUMBER OF BRAKE-BEAMS.

III. *To get the force which must be exerted at the upper end of each brake-beam lever:* If the brake-beam is attached to the lever between its two ends (as in fig. 404) MULTIPLY THE PRESSURE ON THE BEAM, IN LBS., BY THE LENGTH IN INCHES OF THE SHORT END OF THE LEVER, AND DIVIDE BY ITS WHOLE LENGTH. If the brake-beam is attached to the end of the lever (as in fig. 405) MULTIPLY THE PRESSURE ON IT, IN LBS., BY THE LENGTH IN INCHES OF THE SHORT END OF THE LEVER, AND DIVIDE BY THE LENGTH IN INCHES OF THE LONG END.

IV. *To get the proportions of the brake-cylinder levers:* If floating-levers are not used (as in fig. 406): TAKE THE FORCE, IN LBS., EXERTED AT THE TOP OF EACH LIVE BRAKE-BEAM LEVER; if floating-levers are used (as in fig. 407), TAKE DOUBLE THIS FORCE AND ADD IT TO THE PRESSURE, IN LBS., EXERTED ON THE BRAKE-PISTON. THEN TO GET THE LENGTH OF THE END OF THE LEVER NEXT TO THE CYLINDER, MULTIPLY ITS WHOLE LENGTH BY THE FORCE EXERTED, IN LBS., ON THE OPPOSITE END OF THE LEVER, AND DIVIDE THE PRODUCT BY THE SUM OF THE FORCES EXERTED AT THE TWO ENDS OF THE LEVER. The length of the other end of the lever could be obtained by multiplying its whole length by the pressure exerted on the piston and dividing by the sum of the forces as before.

QUESTION 687. *In what distance can trains be stopped at different speeds with a quick-acting automatic brake?*

Answer. This to some extent depends upon the number of wheels in the train to which the brakes are applied. If all the wheels in a train, excepting the truck wheels of the locomotive, have brakes, it can be stopped quicker than is possible if the driving-wheels have no brakes, or if the cars have six-wheeled trucks on which brakes are seldom applied to the middle pair of wheels. Under the most favorable conditions, with all the cars empty, trains can be stopped in about the following distances:

At 20	miles an hour,	120 ft.
" 30	" " "	270 "
" 40	" " "	480 "
" 50	" " "	750 "
" 60	" " "	1,080 "

If the cars are loaded, these distances would be increased in proportion to the loads.

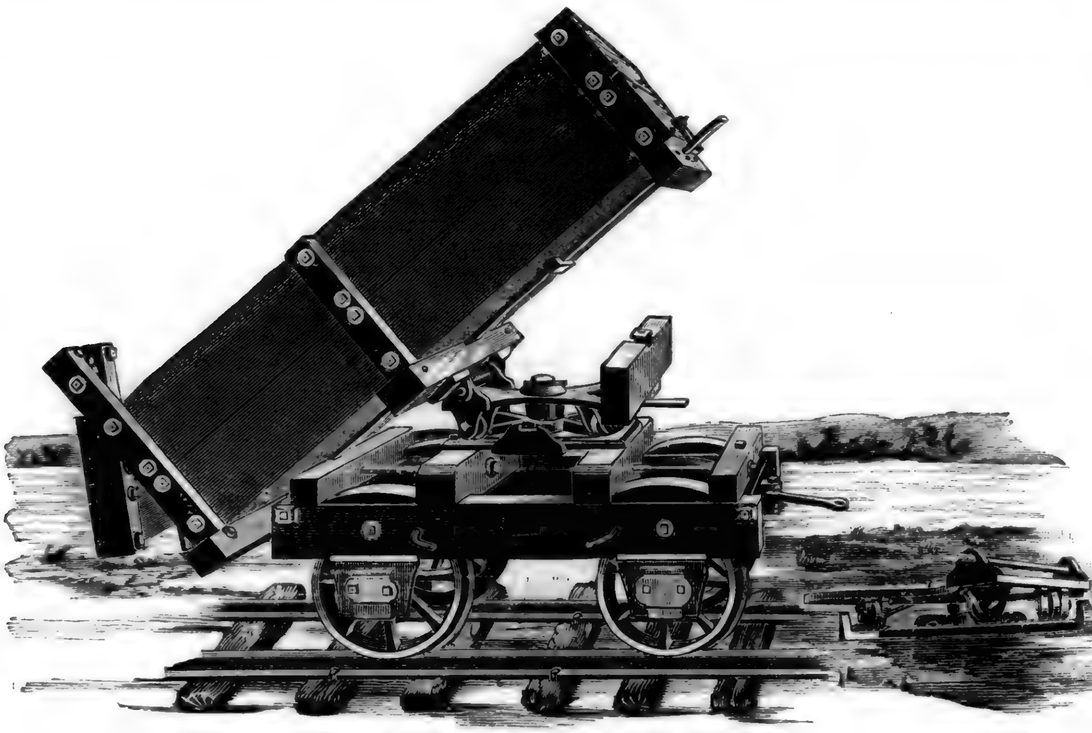
(TO BE CONTINUED.)

Manufactures.

A New Rotary Dumping Car.

THE accompanying illustration shows a new and very convenient pattern of dumping car for contractors' use and similar purposes. The car shown is of 30-in. gauge, and has a capacity of 1½ cubic yards of earth. It is carried on four 16-in. chilled wheels, with 2¼-in. axles and outside bearings. The frame is of 4 × 6 in. white oak, and is 50 in. long and 46½ in. wide. The body is of white oak 5 ft. long, 5 ft. wide and 16 in. deep. The wheel base is 30 in. and the total height above the rail only 47 in. The gate of the car swings outward, and the hinge is so arranged that the bolt is free from all bending strains.

The chief peculiarity of this car is in the turn-table, which is a new device of the manufacturers. This arrangement is very simple, consisting of two plates of cast iron, the total weight of which is 230 lbs. The bottom plate rests on the middle cross-sills of the frame and is 20 × 20 in. square, having cast from the center a hub 2½ in. diameter, which projects above the plate 6½ in., and two latch rests. The top casting contains four small rollers, a wrought-iron latch and dumping lugs, and revolves with the body of the car. The wrought-iron latch is 12½ in. long, and is held in position by a bolt and a guard. When the car is turned to dump on either side this latch drops auto-



A NEW ROTARY DUMPING CAR.

matically into the rests on the bottom casting, thus holding the car firm; when running, it prevents the car from turning or slewing in the least. It can be raised by the hand or foot when it is desired to revolve the car. The advantage of this arrangement is that the car will dump on both ends or sides. Its construction will be very readily understood from the engraving.

This car is manufactured by Ryan & McDonald, of Waterloo, N. Y.; it is made all sizes, from 30 to 38 in. gauge and from 1½ to 2½ yards' capacity. These cars are used by contractors, in brick-yards and for similar purposes, and have given general satisfaction.

Bridges.

THE Hilton Bridge Company, Albany, N. Y., has just completed a double-track railroad bridge over the Erie Canal at Rome, N. Y., for the New York Central & Hudson River Road. This bridge is a through lattice bridge with two trusses, and is 90 ft. span. It is made of open-hearth steel, with all holes for the rivets drilled. The floor is of solid plate, carrying a track with gravel ballast; the roadway being the same as at any other point. The bridge was designed by Messrs. Walter Katte and George H. Thomson.

THE Smith Bridge Company, Toledo, O., recently completed a highway bridge over the Passaic River, at Avondale, having a draw span 165 ft. long and two fixed spans of 90 ft. each.

THE Phœnix Bridge Company is building a cantilever bridge over the Colorado River at Red Rock, Ari. The dimensions of this bridge are 990 ft. from center to center of anchorage; 660 ft. from center to center of main piers; the suspended span will be 330 ft. long, the cantilever arms 165 ft. each and the anchor arms 165 ft. each. The suspended span will have a depth of truss of 55 ft. and the cantilever will have a depth of truss of 101 ft. over the main piers.

Blast Furnaces of the United States.

THE *American Manufacturer* gives its usual monthly statement of the condition of the blast furnaces on March 1, which is thus summed up: "The totals are as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	59	11,568	109	12,412
Anthracite	100	33,383	97	24,162
Bituminous	152	97,783	74	36,548
Total	311	142,734	280	73,122

"The table shows a decrease of 15 furnaces in blast on March 1 as compared with the number in blast February 1. There has been a decrease of 7 in the number of charcoal, 4 in anthracite and an increase of 6 in the number of bituminous. The weekly capacity of the furnaces in blast has been increased from 134,815 tons to 142,734 tons, or 7,819 tons.

"The appended table shows the number of furnaces in blast on March 1, 1889, and on March 1, 1888, with their weekly capacity.

	March 1, 1889.		March 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	59	11,568	62	11,713
Anthracite	100	33,383	102	29,066
Bituminous	152	97,783	129	76,800
Total	311	142,734	293	117,579

"This table shows that the number of furnaces in blast, March 1, was 18 more than at the same date in 1888, the changes being distributed as follows: Charcoal, decrease, 3; anthracite, decrease, 2; bituminous, increase, 23. The weekly capacity of the furnaces blowing was 142,734 tons; at the corresponding date last year, 117,579, an increase of 25,145 tons, with 18 more furnaces in blast."

Coal Production in 1888.

COAL production in the United States in 1888, as compared with 1887, is estimated by the Statistical Bureau of the Geological Survey as follows, in tons of 2,000 lbs.:

	1888.	1887.
Anthracite	43,578,000	39,506,255
Bituminous	94,937,700	84,509,000
Total	138,515,700	124,015,255

Pennsylvania was the largest bituminous producer, with 32,500,000 tons. Ohio reported last year 11,950,000 tons, Illinois 11,855,200, and West Virginia 5,498,800; no other State produced over 5,000,000 tons. Coal was mined in 30 States and Territories.

The above estimate does not include coal consumed at mines, which is estimated at 6,848,000 tons, making a total of 145,363,000 tons taken out last year.

Cars.

THE South Baltimore Car Works are building 50 Eastman heater cars for the Baltimore & Ohio, and have taken a contract for 650 box cars for the Richmond & Danville Railroad.

THE Baltimore & Ohio Company has contracted for 150 box, 300 flat, 6 postal, 4 baggage, and 26 passenger cars to be furnished by the Finance Company, of Pennsylvania, under a car trust agreement.

THE Middletown Car Works, Middletown, Pa., is building 350 box cars for the Philadelphia & Reading Road.

THE Harrisburg Car Manufacturing Company is building 150 box cars for the New Jersey Central.

THE Seaboard & Roanoke Railroad has just completed 100 box cars at its shops at Portsmouth, Va.

THE Muskegon Car Company, Muskegon, Mich., is building a number of Zimmerman refrigerator cars to be used in carrying beer to Texas.

THE Safety Car Heating & Lighting Company, New York, is supplying its heating apparatus to the New Jersey Central and the Kansas City, Fort Scott & Gulf Roads. It is supplying its heating system to the sleeping cars of the Wagner Company.

AT the last annual meeting of the Jackson & Woodin Manufacturing Company, at Berwick, Pa., the following officers were elected: President, C. R. Woodin; Vice-President and General Manager, C. H. Zehnder; Secretary, Frederick H. Eaton; Treasurer, Garrick Mallery. Mr. H. F. Glenn was appointed General Superintendent. This Company is now making a specialty of castings for elevated roads and street railroad structures, and is filling contracts for such work for the Union Elevated Railroad, Brooklyn, N. Y., and for the electric railroad now under construction on the Bentley-Knight System, in Fulton Street, New York. In the car department the Company is completing 250 box cars for the Delaware & Hudson Canal Company, and has just finished some coal cars for the Union Elevated Road.

Locomotives.

THE Schenectady Locomotive Works, Schenectady, N. Y., have recently completed 8 twelve-wheel locomotives for the Central Pacific, and 7 mogul engines for the Duluth & Iron Range. The works are building a number of engines for the Charleston, Cincinnati & Chicago Railroad.

THE Pittsburgh Locomotive Works recently completed an order for the St. Louis, Vandalia & Terre Haute Road.

THE Rhode Island Locomotive Works, in Providence, are building 12 engines for the Kings County Elevated Railroad in Brooklyn.

THE Cooke Locomotive Works, in Paterson, have recently delivered rotary steam shovels to the New York Central and the Denver & Rio Grande Road.

THE Baltimore & Ohio Company has contracted to purchase 71 new locomotives from the Finance Company, of Pennsylvania, under a trust arrangement.

Marine Engineering.

THE Cleveland Ship Building Company, Cleveland, O., is now full of work, and its yards and shops are very busy. This company is successor to the Cuyahoga Steam Furnace Company, which was established in 1832, and is therefore a contemporary of the JOURNAL.

THE Atlas Iron Works, San Francisco, recently completed a steam launch 36 ft. long, 9 ft. beam, and 5 ft. deep for the Kodiak Packing Company, for service in Alaska. The engines are compound, with cylinders 6 in. and 10½ in. in diameter and 8-in. stroke. The peculiarity about this launch is that instead of the usual condenser she is supplied with, what may be called an external condenser, consisting of a brass pipe projecting from the port side of the boat amidships, which, extending along the side, is connected with a series of 32 small tubes, each 3 ft. in length, arranged vertically under the counter, somewhat in the form of a gridiron. The inventor, J. D. Jardine, claims great economy in weight for this arrangement.

Manufacturing Notes.

THE Johnson Railroad Signal Company of Rahway, N. J., has opened an office in the Rock Island Building in Chicago. The Company will keep, on exhibition in this office, a full-size Johnson interlocking machine, with other signaling appliances.

THE Creditors' Committee of the Reading Iron Works, Reading, Pa., which recently failed, have submitted a plan for reorganization. The Committee states that this plan is apparently the only one which will avoid the very serious loss which must be caused by disposing of the Works, under forced sale. The plan provides that all claims less than $1,000 be settled by the payment of 60 per cent. on their face in cash. This will reduce the floating debt to $1,300,000. This sum it is proposed to adjust by issuing to the creditors 40 per cent. in 6 per cent. second-mortgage bonds, and the remaining 60 per cent. in third mortgage bonds to be entitled to 6 per cent. interest if earned; all net earnings after payment of interest to be paid into a sinking fund and the voting power of the present stock to be vested in the trustees of the mortgage, so that the creditors will have full control of the management.

RIEHLE BROTHERS, in Philadelphia, report recent sales of one 20,000-lbs. horizontal testing-machine to the Bridgeport Brass Company; one 20,000-lbs. vertical testing-machine to the United States Naval Academy, and a number of smaller testing-machines to different parties; also a large number of furnace-scales, track-scales, and presses. The firm has recently filled large orders for platform-scales to go to South America.

THE Westinghouse Air-Brake Company has placed an order with Manning, Maxwell & Moore, of New York, for 214 lathes for their new shop now under construction. This is probably the largest order for machine tools ever placed at one time.

J. M. Foster, of New York, is supplying his steam-pressure regulator for a number of locomotives now being constructed at the Baldwin Locomotive Works. The Pennsylvania Company has also ordered a number of these regulators to be sent to its Fort Wayne and Alleghany shops, for use on its locomotives. The Philadelphia, Wilmington and Baltimore is also applying these regulators on its locomotives. Mr. Foster recently furnished one of his 10-in. pressure regulators to the Cincinnati Water Works, and now has an order for one of the same size for Asheville, N. C.

The Phœnix Machine Company, of Cleveland, is building 18 cranes for the Anniston Pipe Company, at Anniston, Ala.; three large cranes for a Milwaukee company ; one for Charleston, S. C.; a large crane for a Chattanooga and one for a Pittsburgh firm.

OBITUARY.

Captain John Ericsson died at his home in New York, March 8, aged 85 years, after an illness of about two weeks. A notice of his life and services will be found on another page.

William S. Barbour, who died in Cambridgeport, Mass., February 24, aged 54 years, had been for 30 years past a civil engineer in Boston and the vicinity. For 14 years past he had been City Engineer of Cambridge, and under his charge several important works had been completed, including the system of sewerage for the city, the Stony Brook improvement and the Harvard Street bridge.

Thomas G. Merritt, who died in New Orleans, February 24, was well known as an engineer. He was for some 10 years past Superintendent of Bridges and Buildings on the Cincinnati, New Orleans & Texas Pacific Railroad and its controlled lines. The long bridge of the New Orleans & Northeastern Railroad over Lake Pontchartrain—the longest pile bridge in the world—was built under his direction. Few engineers, probably, had wider experience and more thorough knowledge of wooden bridges and trestles than Mr. Merritt.

Charles J. Brydges, who died suddenly in Winnipeg, Man., February 18, aged 62 years, was born in England, and for some years was employed on the London & Southwestern Railroad. In 1853 he went to Canada as Managing Director of the Great Western Railroad, and in 1862 was appointed Managing Director of the Grand Trunk. He continued at the head of the Grand Trunk in Canada until 1874, when he was appointed General Superintendent of Government Railroads, and for four years had charge of the Intercolonial and the Prince Edward Island Railroads. In 1878 he retired, was shortly chosen Land Commissioner of the Hudson Bay Company, which office he held until his death.

General David P. DeWitt, who was born in Hoboken, N. J., July 10, 1817, died in Middletown, N. Y., February 26, 1889, aged 72 years. In 1832 Mr. DeWitt entered the West Point Military Academy ; he graduated, and was commissioned as Second Lieutenant, Second Artillery, United States Army in 1836. He afterward resigned and entered the employ of the New York, Lake Erie & Western Railroad. After a long service with this company he was engaged in civil engineering in Canada, and afterward in railroad contract work in Ohio, Pennsylvania, and Kentucky. In 1861 he re-entered the United States Army and served during the War, retiring with the rank of Brigadier-General. After his retirement he entered the service of the United States Express Company, but gave up active business several years ago.

PERSONALS.

Millard F. Wright has been elected Superintendent of Water Works at Lowell, Mass.

A. C. McGrath has been appointed Superintendent of Water Works at Chambersburg, Pa.

G. H. McCord has been appointed Secretary and Treasurer of the Indianapolis Car Works.

William H. Langley has been appointed Commissioner of Public Works of the city of Detroit.

Colonel J. H. Averill has resigned his position as Superintendent of the South Carolina Railroad.

F. J. Krom is appointed Assistant General Car Agent of the Lehigh Valley Railroad, with office at Sayre, Pa.

M. C. Kimberley has been appointed Assistant General Superintendent of the Northern Pacific Railroad.

J. F. Clarke, Division Engineer of the Lake Shore & Michigan Southern Railroad at Toledo, has resigned, and will engage in business in Georgia.

Professor W. S. Chaplin, of the Lawrence Scientific School, at Cambridge, Mass., has been obliged to retire from active work temporarily on account of ill health.

H. H. Filley, who has been in Mexico for some time past, has returned to Kansas City. Mr. Filley still remains Consulting Engineer for the Mexican National Construction Company.

L. Finlay has resigned his position as General Master Mechanic of the St. Louis, Arkansas & Texas Railroad. His present address is No. 902 West Fourth Street, Little Rock, Ark.

Colonel Aldace F. Walker resigns his position as a member of the Interstate Commerce Commission to become Chairman of the new Interstate Railroad Association, a position for which he is well fitted.

Samuel Spencer, late President of the Baltimore & Ohio Railroad Company, has accepted a position with the banking house of Drexel, Morgan & Company. It is understood that he will have charge of the very extensive railroad interests of that firm.

Lieutenant Colonel Adelbert R. Buffington has been promoted to be Colonel in the Ordnance Corps of the Army, in place of Crispin, deceased. Major Joseph P. Farley is promoted to be Lieutenant-Colonel in the same corps, and Captain Otho E. Michaelis to be Major.

James T. Harahan, who left the Louisville & Nashville a few months ago to become Assistant General Manager of the Lake Shore & Michigan Southern, has now left the last-named road to accept the position of General Manager of the Chesapeake & Ohio Railroad, with office in Cincinnati.

Colonel W. P. Craighill, U. S. Engineers, has started for Europe under orders from the War Department to investigate the latest improvements in canal locks and hydraulic lifts, for canal purposes. He is accompanied by Colonel George H. Mendell and Major James C. Post, U. S. Engineers. These officers are charged with the duty of designing a lock to overcome the obstructions in the Columbia at the Dalles, Oregon.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, March 6, the deaths of W. S. Barbour, Edward Baumann, and E. S. Philbrick, members, were announced.

The Secretary read a paper by James H. Cunningham on English Railroad Tracks, discussing Mr. Tratman's paper on the same subject. This was followed by a verbal discussion in which Messrs. Sloan, T. C. Clarke, Croes, Wegmann, Devin, Buck, and Tratman took part.

The Tellers announced the following elections :

Members : Walter L. Cowles, Cleveland, O. ; Paul Didier, Pittsburgh, Pa. ; Herbert S. Holt, Sherbrooke, P. Q. ; William C. Kernot, Melbourne, Australia ; Henry K. Owens, Seattle, Wash. ; Andrew McC. Parker, New York ; Albert H. Porter, Walter P. Rice, Cleveland, O.

Juniors : Stewart Johnston, Pittsburgh, Pa. ; Augustus S. Kibbe, Albany, N. Y. ; Walter F. Whittemore, Hoboken, N. J.

American Institute of Mining Engineers.—The fifty-third meeting was held in New York City, beginning February 19. The address of welcome was made by Andrew Carnegie, in the absence of Mayor Grant. The annual address was made by the President, Professor William B. Potter, of St. Louis, Mo.

The annual report of the Secretary showed the present total membership to be 1,830.

During the Convention the following papers were read and discussed by members present :

End-lines and Side-lines, by Dr. R. W. Raymond, New York City; Electric Storage Batteries, by P. G. Salom, of the Julien Storage Battery Company ; Magnetic Separation of Iron Ores, by John Birkinbine and Thomas A. Edison ; Electric Power Plant in the Comstock Mines, by N. W. Perry ; Steel Rails, by F. A. Delano ; Rail Sections, by R. W. Hunt ; the Determina-

tion of Silicon in Ferro-Silicons; the Elliott Locked Rope, by E. G. Spilsbury, Trenton, N. J.; The Genesis of a Nail, by Oberlin Smith, Bridgeton, N. J.; Results of the Storage of Water in Arizona, by W. P. Blake, New Haven, Conn.; the Re-opening of the Tilly Foster Iron Mine, by F. H. McDowell, New York City; the Comparative Economy of Air-Compressors, by J. E. Denton, Hoboken, N. J.

The following officers were elected: President, Richard Pearce, Argo, Col.; Vice-Presidents, Eckley B. Coxe, Drifton, Pa., Charles Macdonald, New York City, and Percival Roberts, Jr., Philadelphia; Managers, J. H. Bramwell, Roanoke, Va., Frank Firmstone, Easton, Pa., and W. H. Pettee, Ann Arbor, Mich.; Treasurer, Theodore D. Rand, Philadelphia; Secretary, Rossiter W. Raymond, New York City.

The Wednesday evening meeting was a joint one with the American Society of Civil Engineers, and was devoted to papers on Steel.

On Friday evening a reception was given to the members of the Institute and their ladies by Mr. and Mrs. A. S. Hewitt.

The Convention, which was one of unusual interest, closed on Saturday, February 23, with an excursion by steamer to the Central Forging Company's Works at Whitestone Landing, the United States Engineer School and Torpedo Station at Willett's Point, and to Fort Hamilton. The process of heating and hammering heavy forgings was witnessed at the Central Company's Works; at Willett's Point the laboratories and museum were inspected, and at Fort Hamilton the dynamite gun was explained by Captain Zalinski.

National Electric Light Association.—The Annual Convention was held at Chicago, beginning February 19.

The Secretary's report showed a total membership of 175.

The following papers were read and discussed: Liquid Fuel, by M. J. Francisco; Petroleum Fuel, by S. S. Leonard; Conduits, Their Material in Relation to Underground Conductors, by A. C. Chenoweth; Disruptive Discharges in Lead Cables, by C. H. Rudd; Municipal Lighting, by F. H. Whipple; Public Ownership of Commercial Monopolies, by A. R. Foote, and Electric Light Stations as Fire Risks, by S. E. Barton.

Other interesting papers were read and discussed by the members.

The following officers were elected for the ensuing year: President, E. R. Weeks, Kansas City, Mo.; Vice-Presidents, A. J. DeCamp, Philadelphia, Pa., and E. A. Maher, Albany, N. Y.; Executive Committee, B. Rhodes, Niagara Falls, B. E. Sunny, Chicago, Ill., C. R. Huntley, Buffalo, N. Y., Dr. O. A. Moses, New York City, J. F. Morrison, Baltimore Md., and T. Carpenter Smith, Philadelphia, Pa.

The Convention, which lasted three days, was largely attended and one of much interest.

New England Water-Works Association.—The regular quarterly meeting was held in Boston, March 13. President Nevons announced the death of William S. Barbour, City Engineer of Cambridge, Mass.

An address upon the Relations of Great Ponds to the Water Supplies of our Cities and Towns was delivered by Mayor Jackson, of Fall River, Mass.

Edwin Darling read a short description of a filter-bed, which had been built in connection with the new pumping station at Pawtucket.

J. A. Tilsen described the method used in repairing a break in a 10-in. wrought-iron pipe located in the bed of the river at Cleveland, O.

Solon M. Allis, Superintendent of the Malden Water Works, asked information as to the life of cast-iron pipe, and was answered by Superintendent Darling.

The Secretary read a Description of the Repair of a Break in a Large Wrought-iron Cement-lined Main at New London, by W. H. Richards, and a paper on a Novel Way of Placing a Bridge in Position, by Charles A. Allen, Worcester, Mass.

Conference of Railroad Commissioners.—The Conference Meeting called by the Interstate Commerce Commission, was held in Washington, March 5, 6, and 7. There were present all the members of the Interstate Commission and representatives from the State Commission of Alabama, California, Connecticut, Florida, Georgia, Iowa, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New York, Ohio, Pennsylvania, South Carolina, Vermont, Virginia, and Wisconsin. There were also present, by invitation, a delegation of the Railroad Accounting Officers, headed by President Marshall M. Kirkman.

The order of business adopted was: Uniform Statistics and Classification of Freight; Railroad Construction; Car Heating and Lighting; Automatic Brakes and Couplers, and Taxation.

In relation to all, except the first-named subject, the meeting took no action, its work being confined to general discussion and conference as to the possibility of securing some uniformity in State Legislation. The importance of such action was generally admitted, and the Conference has undoubtedly resulted in a good understanding and in preparing the way for concerted action hereafter.

In relation to Uniformity of Statistics, the subject was brought before the Conference in an elaborate paper by H. C. Adams, Statistician of the Interstate Commission. The subject was referred to a committee consisting of Mr. Adams, Mr. Kirkman, and five State Commissioners. This committee reported a form for railroad reports, which was based upon that prepared by the Interstate Commission, with some modifications. This form was approved by the Conference, and it is decided to take such action as may be necessary to secure its adoption in all the States. It was also resolved to make the report year end with June 30. It was resolved to hold Conferences annually, and a committee of three was appointed to fix the time and to call the next meeting.

New England Railroad Club.—The March meeting of this Association, on March 13, was devoted to the annual dinner, which was largely attended by members and invited guests, and was thoroughly enjoyed by those present.

New York Railroad Club.—At the regular meeting, March 21, the subject for discussion was the Use of Iron in Freight Car Construction. A paper was read by Mr. G. W. Ettenger on the Tubular Form of Iron Freight Car Framing, and the subject was discussed at considerable length by those present.

Northwest Railroad Club.—At the regular meeting in St. Paul, March 5, the subject for discussion was the Best Method of Heating Passenger Cars in the Northwest. It was opened by a paper read by Mr. W. H. Lewis, which was followed by experiences of different heating systems given by members present.

Western Railway Club.—At the regular meeting in Chicago, March 19, the first subject for discussion was Axles for 60,000 lbs. Cars, continued from the previous meeting.

This was followed by a discussion on Draw-bar Rigging, which was introduced by a paper read by Mr. C. A. Schroyer, of the Chicago & Northwestern Railroad.

Baltimore & Ohio Employes' Relief Association.—The report of this Association, for the year ending September 30, 1888, shows that at the close of the year there were 20,267 members upon the books. The total receipts for the year were $359,278, and the expenditures were $358,983, of which the sum of $301,992 was for payment of benefits and $56,991 for physicians' bills, hospital accounts, and current expenses. The number of benefits paid during the year was 13,254, of which 78 were for deaths from accidents; 139 for deaths from natural causes; 3,746 for injuries from accidents; 6,629 for disabilities from sickness; while in 2,662 cases only the payment of physicians' bills was required. The total amount paid out by the Association in benefits from its organization, May 1, 1880, up to September 30, 1888, was $1,828,265, paid to 80,814 persons.

The report of the pension feature shows that there were on the list at the close of the year 154 pensioners, and the amount paid during the year was $23,438. This pension feature is sustained entirely by the Company.

The savings fund and building feature shows that the total amount of deposits is $446,991, the number of depositors being 1,283. The outstanding loans, to 706 borrowers, amount to $332,384 and the investments of the funds to $51,500. The loans are made for the purpose of purchasing and building, improving houses, and removing liens on property.

Engineers' Club of Philadelphia.—A regular meeting was held in Philadelphia, February 16. No papers or notes were ready for presentation, and after disposing of the order of business the meeting adjourned.

At the regular meeting, March 2, the Secretary presented a communication from Mr. John C. Trautwine, Jr., now in England, covering interesting descriptions of his journey thither, of the *City of New York*, in which he sailed, the Grand Junction Water Works, and the new Tower Bridge, London, with illustrations.

Some remarks on points of English, as compared with American engineering were made by Messrs. T. Carpenter Smith and Frederic Graff.

The Secretary presented, for Mr. Samuel Tobias Wagner, a set of Conventional Signs for Bridge Rivets which Mr. Wagner refers to as being generally adopted as a standard, and having special merits.

There was some discussion by Mr. Henry B. Seaman, wherein he pointed out what he considered some of the defects of this particular system.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting was held in Pittsburgh, February 19. A paper was read on International Standards for the Analysis of Iron and Steel by Professor John W. Langley. Mr. H. B. Hibbard read a paper on Welding Metals by Electricity, illustrated by samples. Both papers were discussed by members present.

A special committee was appointed to consider and report upon the Best Methods of Constructing and Maintaining Public Highways, and to recommend legislation on this subject.

Engineers' Club of Cincinnati.—A regular meeting was held in Cincinnati, February 6. Mr. Edward Flad, of St. Louis, was chosen a member.

Mr. E. J. Carpenter, who is in charge of the work of dredging done by the Government on the Ohio River, entertained the Club with a description of the work performed by the two dredges engaged in this service, describing the construction of the dredge-boats, which were built under his supervision to special plans prepared by him. The boats are, with the exception of minor parts, made entirely of iron and steel. Mr. Carpenter illustrated his lecture by lantern views, which served to show more clearly the various kinds of work performed in moving logs, stones, wrecks, and bars which form in the channel and obstruct navigation.

The regular meeting of the Club was held March 6. One new member was admitted and applications received from four.

The date of the meeting was changed from the first Wednesday to the fourth Thursday in each month.

A paper on the Methods and Results of Accurate Measurements of Base Lines in General was read by Mr. Carl Schenk.

A lunch, provided by the Executive Board, was enjoyed by the members.

Western Society of Engineers.—A regular meeting was held in Chicago, February 6. Messrs. A. D. Whitton, L. L. Wheeler, and J. H. Flagg were chosen members.

The Committee on Highway Bridges submitted a report, with a copy of the bill now before the Missouri Legislature, and stated that while some changes in details were desirable, the proposed bill was the best method yet recommended for remedying existing evils. At the present time it was not considered best to attempt to secure any legislation in Illinois.

The Committee on Standard Drawing Papers reported progress. The Committee on Employment ask for instructions, and after some discussion it was decided that the Committee be discharged and that arrangements be made to receive applications for employment, and to enter the same in a book. This was followed by considerable discussion, and the matter was closed by placing Mr. Liljencrantz in charge of the subject. After some general discussion on the work of the Society the meeting closed.

Minneapolis Society of Civil Engineers.—At the regular meeting held in Minneapolis, March 6, a paper on the Permanent Improvement of Highways was read by George E. Crary, which called out a lengthy discussion, branching into the different kinds of street pavements, and their merits.

Civil Engineers' Society of St. Paul.—A regular meeting was held in St. Paul, Minn., February 4. Messrs. C. J. A. Morris, W. W. Curtis, and R. Davenport were appointed the Committee on Membership. A communication from the Engineers' Club of Kansas City, relating to transfer of membership among different engineering societies, was read and referred to a special committee.

The paper of the evening was read by Mr. R. J. Johnson on Testing of Water Mains, by the Use of Pressure Gauges.

A regular meeting was held in St. Paul, March 4. The special Committee upon Interchange of Membership reported in favor of a plan for the same, provided all the societies would join. The Committee was continued with instructions to correspond with other societies on the subject.

The Committee on Bridge Legislation presented a report, accompanied by a copy of the act presented to the Missouri Legislature, upon this subject. This report was discussed at length by Messrs. Horton, Loweth, Osborne, Rockwell, Munster, and Mason. The general feeling, as expressed by the speakers, was rather against legislative enactments, but in favor of compelling plans and strain-sheets to be filed in some place accessible to the public; also that parties building bridges should be held strictly responsible for their safety, and liable for damages resulting from the failure.

The Secretary was instructed to have a list of the members printed and distributed.

Engineers' Club of St. Louis.—A regular meeting was held in St. Louis, February 20. Messrs. Whitfield Farnham, E. L. Goltstein, Frank S. Ingoldsby, and R. H. Phillips were elected members.

The special Committee on a Closer Union of Engineering Societies reported progress and ask for further time, which was granted. The Executive Committee submitted a special report on Transfer of Membership, which was laid over for further consideration. The Committee on Highway Bridges reported that a bill had been submitted to the Legislature. Professor Johnson then read a paper on Cast Iron; Strength, Resilience, Tests, and Specifications. The paper was very interesting, and was illustrated by drawings and formulæ. The author had devoted a great deal of time and study to the investigation of this question, and had made numerous experiments in the Washington University Testing Laboratory. He showed that the tensile strength varied from 17,000 to 36,000 lbs. per square inch, and that from 20,000 to 25,000 lbs. tensile strength should be required. He showed that experience did not bear out the commonly accepted theory, that the outside portion of a casting was stronger than the inside. In the author's opinion, the resilience or the ability of the casting to withstand shocks was by far its most important characteristic. He showed that repeated shocks resulted in a loss of resilience and that the Heisler testing machine, which is in use in the East, was open to objection on this score. Messrs. Russell, Bouton, and Wheeler took part in the discussion.

The Secretary then read a brief discussion by William B. Knight of Professor Johnson's paper on cable yokes. The author gave some data from Kansas City cable roads, showing that the strength of the yokes did not affect the slot closure. In some places it had been found necessary to break the yoke in two at the bottom, which had caused no bad results. He even thought that a good road could be built without yokes.

A regular meeting was held March 6. E. L. Goldstein, F. B. Ingoldsby, and R. H. Phillips were accepted as members of the Association.

A paper on Improving the Channel of the Mississippi, by Mr. Winslow Allderdice, was read by Professor Johnson.

Mr. Richard S. Elliott explained his plan for deepening the Mississippi channel by means of water jets under high pressure. Professor Johnson called attention to the success of some experiments made by the United States engineers at Horsetail Bar, with crude apparatus of a similar nature.

Engineer's Club of Kansas City.—A regular meeting was held March 4.

The Committee on Transfer of Members reported that copies of the constitution of the various Societies had been received and were being looked over before the proposal of any scheme.

A paper on Strengthening Railroad Bridges was read by Mr. C. E. Taylor. This paper was discussed by Mr. Goldmark.

Mr. Breithaupt reported progress on the question of Bridge Reform.

Boston Society of Civil Engineers.—At the annual meeting, March 20, the election of officers for the ensuing year resulted as follows: President, Desmond Fitzgerald; Vice-President, John R. Freeman; Secretary, S. Everett Tinkham; Treasurer, Henry Manley; Librarian, Frank W. Hodgdon, and Member of Board of Managers, Winfield S. Chapin. President Fitzgerald delivered his annual address.

Master Mechanics' Association.—The following circular has been issued by Secretary Angus Sinclair from his office, No. 140 Nassau Street, New York:

"The Executive Committee have made arrangements to hold the next Annual Convention at Niagara Falls, beginning Tues-

day, June 18, with headquarters at the International Hotel. The terms of $3 per day have been secured for members and others.

"The proprietor of the hotel mentioned has agreed to reserve 100 rooms for the use of members. All who wish to secure rooms should apply to Mr. A. H. Gluck, Manager, International Hotel, Niagara Falls, N. Y."

Master Car-Builders' Association.—The following circular has been issued from the Secretary's office:

"The Master Car-Builders' Committee appointed at the Annual Convention, held at Alexandria Bay, June, 1888, to submit an axle for 60,000 lb. cars, request the following information:

"1. How many cars of 50,000 lb. capacity have you in service?

"2. How many of 60,000 lb. capacity?

"3. Give the dimensions of the axles used under the above cars.

"4. In case you contemplate any change in the above axles, give the dimensions you propose changing to, in red ink.

"5. Should you have no cars in service of greater capacity than 40,000 lbs., give the dimensions you recommend for 50,000 lb. and 60,000 lb., in red ink.

"6. Replies to these questions should be filled in on the back of this sheet, and forwarded to the Chairman of the Committee at Aurora, Ill., if possible by March 15, 1889.

G. W. RHODES, *Chairman*,
JOHN S. LENTZ,
R. MCKENNA,
Committee.

The Committee on Standard Brake Gear for Air-Brake Cars and Brake-Shoe for Iron Beams (consisting of Messrs. E. B. Wall, G. W. Rhodes, and George Hackney) proposes to make tests of the different forms of the iron beams on the market.

Manufacturers of beams have been requested to forward beams for test, but the Committee understands that there is much private investigation under way, into the subject of iron beams, by various railroad companies and individuals connected with railroad companies.

The Committee is anxious to make its report to the Association as complete as possible, and would be glad to communicate with any persons having beams which they would like to submit for examination and report to the Association.

The Committee has stipulated to the advertised manufactures that the beams sent for test shall not show a deflection of more than $\frac{1}{16}$ in. under a load of 15,000 lbs.

All parties desiring to communicate with the Committee on the subject of brake-beams will please address their communications to Edward B. Wall, Superintendent Motive Power, Pennsylvania Lines West of Pittsburgh, Southwest System, Columbus, O.

The Committee on Car Heating has issued a circular requesting answers to the following questions:

1. Name of system in use or trial; 2. Number of locomotives equipped; 3. Number of cars equipped; 4. Number of cars in train to which heat can be transmitted; 5. What is the heating medium; 6. What pressure is carried in main pipes; 7. What pressure is carried in heating pipes; 8. How is the temperature regulated and does it require constant attention; 9. What provision is made for retaining a comfortable temperature when train is not connected to locomotive; 10. If traps are used, what kind and where located; 11. What kind of flexible connection is used between cars; 12. What couplers are used; 13. What has been the general results with couplers and connections; 14. What has been the general results with this system of heating.

Replies are to be addressed to the Chairman, F. L. Sheppard, at Altoona, Pa., as soon as possible.

NOTES AND NEWS.

The Latest Rapid Transit Scheme.—The accompanying illustrations show the latest plan for rapid transit, devised by a Western inventor, who proposes that we shall all individually be independent of monopolies and able to make our way back and forth in the quickest time and by the most direct route. Space will not permit us to enter fully into the details of this invention, which are very fully set forth in the patent specifications, but the engravings will show sufficiently well its general character. Fig. 1 shows the passenger in transit, and the artist has well depicted the graceful ease with which a journey may be effected and the elegant appearance which he—or she—will present upon the road. Fig. 2 shows the passenger just ready for flight with his broad pinions spread, and attention may be called to the magnificent and stately appearance presented by these pinions and by the—well, steering apparatus, to speak politely. The Patentee does not claim, but we might suggest,

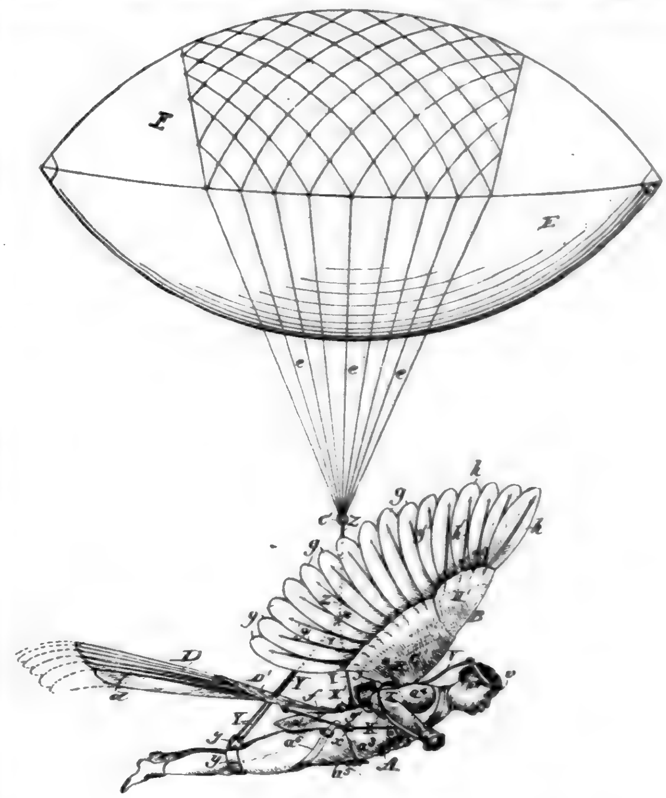


Fig. 1.

were we sufficiently familiar with such matters, that the aforesaid steering apparatus might serve the purpose of what we believe is called a bustle, for ladies using it, when they might condescend to alight upon the earth.

The inventor explains that the balloon part is not absolutely necessary, as the wings and tail can be used without it. The wings, he says, operate with practically the same effect as the wings of an eagle—which might be a dangerous admission, were the eagle in a position to file objections in the Patent Office—and he also suggests several modifications, which might be em-

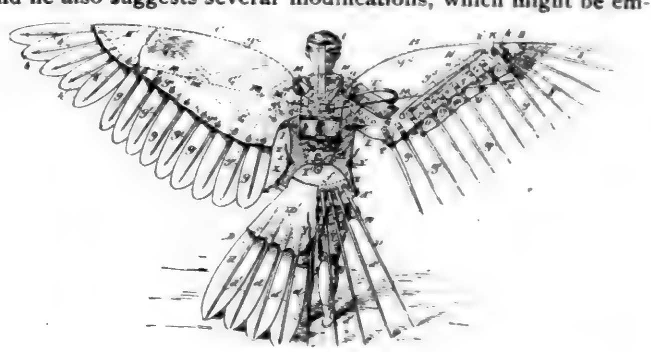


Fig. 2.

ployed, as, for instance, the use of electric power for operating the machinery.

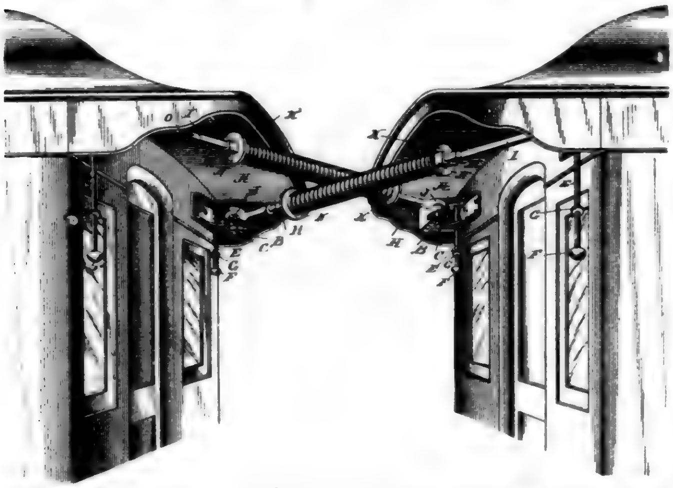
His patent contains no less than 20 claims, but in a general way it may be said that it covers a combination of a jacket or bodice with wings and tail, and the various combinations of springs and other machinery, by which they are propelled.

The Patentee of this machine is Reuben Jasper Spalding, of Rosita, Col.; his patent is dated March 5th, 1889, and numbered 398,984. A model is filed with the patent, but it is not stated whether the machine has ever been put into practical use.

The Foulis Railway Carriage Heater.—Recently there was exhibited at St. Pancras Station, in London, a railway carriage for the Glasgow & Southwestern Railway, fitted with the Foulis heater. We may briefly explain that the gas flame in the carriage roof is the source of heat, and that it is rendered available for warming the passengers by means of a tiny boiler above it, and a system of hot-water pipes connected with heaters below one of the seats. The difficulty which arises from the source of heat being at the highest point of the circulating system instead of at the lowest is got over in a very in-

genious manner. From the top of the boiler there rises a tube, which opens into a small chamber, its mouth being closed by a light valve. When ebullition occurs, the water rushes up this tube, and lifting the valve escapes into the chamber above. The flow tube is connected to this chamber, and the return tube to the boiler. The course of the circulation is from the bottom of the boiler, up the rising tube, through the valve into the chamber, down the flow tube, into the heating appliance, and up the return tube to the boiler. It will be seen that the ebullition lifts the water from the boiler into the chamber above, and then the circulation is maintained by gravity; the descending column being longer and hotter than the ascending column. It is stated that the appliance will keep a carriage at 54° Fahrenheit during winter weather, and that the combined cost for lighting and heating a compartment is one tenth of a penny per hour.—*London Engineering*.

Preventing Oscillation of Cars.—The accompanying illustration shows a recently invented device for lessening the oscillation or lateral movement of the cars in the train. It consists, as will be seen, of angular coupling plates *B B* secured to the cars, provided with coupling pins *C C*, which can be operated



from the platform. The form of these coupling plates is no material to the patent.

Between each pair of couplings, but extending obliquely across the ends of the car, so that one end connects with one of the cars at one side and the other end at the opposite side of the adjacent car, is a connection consisting of the rods *H I*, arranged in pairs, each provided at their outer ends with eyes *J*, through which the coupling-pins pass. Sleeved upon these rods, and holding the inner ends of each pair thereof parallel and close together, are disc-like plates *K*, between which, and also sleeved upon the rods, are confined strong coil-springs *L*, the said disc in turn being confined between lugs *M N*, rigidly secured to the rods *H* and *I*, respectively, one near the extreme end of the rods and one toward the opposite end, both beyond the discs, the whole forming a sliding or telescope connection between each pair of rods, which are guided and prevented from separating solely by the disc-like plates *K*. The lugs on the rods are so located that the springs at all times are under a slight tension, and are so arranged that no matter which direction the rods are moved relative to each other the spring will be compressed, one lug on each rod operating at a time and in one direction, while the other pair of lugs operates when the rods are moved in the opposite direction, both, however, as aforesaid, operating to compress the spring.

Thus it will be seen that with the two sets of rods and springs or the double yielding connection shown in the drawings extending obliquely between the adjacent cars, whenever either car lurches to one side or the other, both connections will operate, although the rods in one connection are extended, while in the other they are telescoped; and it is therefore obvious that either one of these connections might be dispensed with and the same result be accomplished; but in that case it would be found advantageous to make the springs stronger than if a pair of such connections were employed.

This device is the subject of a patent, No. 397,902, issued recently to William E. Elliott, of Chicago.

Engineering Schools in Japan.—In his address at the third Commencement—as we should call it in this country—of the Imperial University of Japan, the President, Mr. H. Watanabe, presented a concise outline of matters related to that institution which will interest all who note the progress of the higher education in the far East. After referring to the departments of Literature, Law, Science, and Medicine, he said that perhaps the outlook of the Engineering College is the most satisfying. The construction of new engineering works and appliances throughout Japan is increasing to such an extent that the graduates of this College are insufficient to meet the demands for properly qualified professional men. Courses in sanitary engineering and the technology of arms and explosives have recently been added to curricula already very full. New buildings on the University grounds just completed for the Engineering College are now ready for occupancy. Of the 35 graduates of this College, 13 are in civil engineering, two each in mechanical engineering, naval architecture and electric engineering, one in architecture, 11 in applied chemistry, and four in mining and metallurgy.

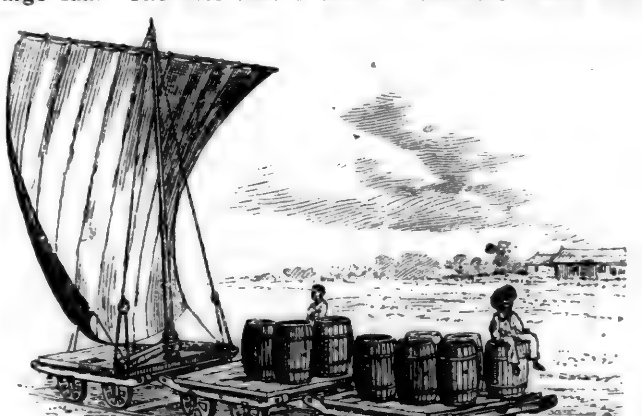
In furthering astronomical ends, the Japanese officials have made a wise move in the consolidation of the three Government observatories at Tokio into one. This is known as the Imperial Tokio Observatory, and is attached to the Mombusho, or Department of Education, with Professor Terao as director. It is thus under the control of the University, and its site is that heretofore known as the Imperial Naval Observatory, in Azabu, whither the instruments and apparatus of the two other former observatories are removed. The principal telescopes are of the best German and English construction.

The total number of students of the University, including elective and special students, is now about 800, and more than 200 scholarships, for the most part on the loan system, are available.

Trade Schools.—The Pratt Institute in Brooklyn, which began its work in 1887, with 12 pupils, is now well established, and has carefully arranged courses, including general technical instruction, and also special courses in the building and other trades, including carpentry, foundry-work, smith-work, machine-work, plumbing, masonry, etc. The Institute is supplied with a number of machine tools, wood-working tools, and other appliances for practical instruction.

The New York Trade School, founded by Colonel R. T. Auchmuty, for the practical instruction of boys in the various building trades, is very successfully at work, and has a large number of students.

A Wind Locomotive.—A naval correspondent of the London *Engineering*, writing from Malden Island, in the South Pacific, says: "The guano fields which are being worked at present are at the other end of the island, and a tramway, about five miles in length, has been constructed to bring the guano down to the pier. The hauling work on the tramway is done by sail power and by hand. There are neither horses nor steam locomotives. The trucks are pushed up to windward, loaded, and then sail is made, and the tram comes along at a fine rate. The engine truck carries a single mast in its center, rigged with a large sail. The first time I saw the train the trucks were



empty. I asked the man in charge to hoist his sail while I took a photograph. He accordingly did so, but the trucks having neither way on them nor ballast in them, the engine promptly capsized. However, I was more fortunate on another occasion, as the annexed engraving shows."

Boiler Explosions.—The *Locomotive*, published by the Hartford Steam Boiler Inspection & Insurance Company, reports for the United States in 1888 a total of 246 boiler explosions, by which 331 persons were killed and 505 injured. The greatest number of explosions reported was 69 in saw-mills and other wood-working shops; of portable and agricultural boilers there were 30, locomotives 23, and steamboats 20. The figures are not, of course, official, but are very carefully collected by the company's agents.

THE RAILROAD AND ENGINEERING JOURNAL.

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NEW YORK, MAY, 1889.

THE offices of the RAILROAD AND ENGINEERING JOURNAL were on May 1 removed from No. 45 Broadway to No. 145 Broadway, on the corner of Liberty Street. The correct address of the JOURNAL will therefore be hereafter No. 145 Broadway, New York City.

CURVES and curvature have always been and will always be the most important consideration in locating a railroad, with the single exception of grades, while the curves have even more influence than the grade in the design and construction of the equipment. Anything which relates to curvature will, therefore, always have interest for engineers. Probably no single point in this connection has been the subject of more discussion, or has been more written about, than the method of passing from a curve to a tangent and *vice versa*—that is, the question of transition curves. The article on this subject, the first portion of which will be found on another page, is intended to give a clear and complete account of the theory and practice of transition curves. It is an addition to the series of articles on the Principles of Railroad Location, which was published in the JOURNAL last year, and will make part of the book, when those articles appear in that form. The present article is not only an account of the experience of others, but is the outcome of much practical work in the field, in the location of new and the relocation and improvement of old ones.

THE naval disaster at Samoa is a proof of how much a modern war-ship is dependent upon its machinery in contending with the elements as well as an enemy. The British cruiser *Calliope*, which escaped with comparatively little injury, did so not because she was the better vessel—for the *Trenton* was an excellent ship of her class, and the German vessels were also good ships—nor because she was better handled, but simply because she had more powerful engines, of comparatively modern design. Had the American and the German ships been supplied with such machinery as we are now putting into our new war-ships they would doubtless have been safe to-day.

NEW railroad projects are plenty at the present time. The *Railway Age*, in a recent number, gives a table in which are enumerated no less than 666 projected lines, covering a total of 53,436 miles, while there are 14,818 miles under construction or under contract. Unfortunately, the *Age* does not discriminate between the mileage actually under construction and that merely under contract, since, under the system prevalent in this country, the letting of a contract is by no means always followed by actual work. A great many roads have been under contract for years on which not a shovelful of dirt has ever been turned, and a contract may, and often does, mean simply an agreement to build a road at some future time, provided certain things are done, which may or may not come to pass. Probably a considerable proportion of this road is, or soon will be, under actual construction, but how large that proportion is, it is impossible to say.

As to roads that are merely projected, the organization of a company is so easy a matter in most of the States, that it goes for very little. The only value which a mere list of new corporations has, is that they are more numerous when railroad building is active, and less so in times of comparative depression ; but it must be said that the formation of new companies generally continues for some time after actual construction has begun to fall off.

We do not intend, however, to intimate that the present is a time of depression. While it is not probable that new railroad construction this year will come up to the figures of 1887 or 1886, there are many indications that it will not fall very much below those of last year. A good many miles of railroad are needed yet and will be built, and a fair proportion of them will be built this year.

THE MASSACHUSETTS RAILROAD COMMISSIONERS' REPORT.

THE Twentieth Annual Report of the Board of Railroad Commissioners of the State of Massachusetts, dated January, 1889, is an unusually interesting volume. It is devoted almost entirely to what may be called the physical or mechanical condition of the railroads of the State, very little space being devoted to the traffic on its lines. It begins, without precursory remarks, with the subject of heating and lighting cars. Heating cars is discussed at considerable length, and the Commissioners give what is perhaps as concise a summary of the state of the art as can now be found in print.

In 1882 the Legislature of Massachusetts enacted a law requiring that passenger cars shall be provided with such safeguards for protection against fire as may be approved by the Commissioners. In 1887 this law was modified so as to prohibit the use of common stoves, and requiring that no other method of heating shall be used without the approval of the Commissioners. The Board was also instructed to investigate and report on the subject. In 1887 a circular was issued in which the adoption of a system of heating by steam from the locomotive was recommended, or at least of such heating appliances as can be used in connection with or readily converted into the system. On May 1, of last year, the Board reported that "the difficulties have not all been surmounted, that there is trouble from the leakage of steam and from the freezing of traps, and

the imperfect action of reducing valves on the engine, yet it is believed that heating by steam from the locomotive is not only practicable and conducive to the comfort and safety of passengers, but is also economical, and should be generally adopted by the first day of October, 1889." Last year, however, the Legislature instructed the Commissioners to make further report on the subject, and continue in force approvals of methods of heating already granted. In view of this they continued their investigations and encountered the ordinary objection, that in case of accident, or from other cause, an engine is detached from a train or unable to supply it with steam, passengers would suffer seriously from cold. This objection the Commissioners, think has very little weight, or, if it has any, it is only an argument in favor of retaining auxiliary heaters in cars, for use in case of failure of the supply of steam from the locomotive.

The objection that there is difficulty in keeping a uniform temperature with steam heat the Commissioners also think has little weight. In the light, or rather in the heat of some past experience, we are inclined to think the Commissioners have considered this objection more coolly than some passengers have during the recent mild weather. Reports reach us of parboiled travelers who were subjected to the temperatures of a Turkish bath, either through defects of the steam-heating apparatus or the neglect or ignorance of the attendants. It is obvious that with the increasing complication of the appliances which are each year added to modern railroad trains, that those who run them must be specially qualified for their duties. It is generally recognized that the sense of color and of sight at a distance, of hearing and of smell varies in acuteness within very wide limitations, and on our best lines of railroad candidates for positions as train hands are examined with reference to their qualifications in some of these particulars before they are appointed. It is not so generally recognized that the sense of temperature also varies greatly in acuteness in different persons. The Massachusetts Commissioners recommend that "a good and good-sized thermometer be placed in every car." It would be an excellent plan to test the sense of temperature of applicants for positions as attendants in passenger cars, but especially porters in sleeping cars. Such an examination could be made in any bath-room where there is hot and cold water, or with a tea-kettle and a pitcher of cold water. It would probably be found that many persons can only distinguish great differences in temperature. From observation and experience almost any traveler would infer that very many brakemen, porters, and conductors cannot distinguish the difference between 50 and 90 degrees of heat in the atmosphere of a car. With steam-heated cars the passengers are at the mercy of the attendants, who may alternately roast and freeze those under their care or reduce them to a condition of semi-asphyxiation, by shutting out all fresh air. The two subjects of ventilation and heating necessarily go together, and it will be impossible to maintain a uniform temperature and pure air in cars unless the attendants have some knowledge of the construction of the apparatus they have under their control and of the principles of ventilation. It must be remembered that a very large proportion of mankind still has an aversion for clean water and fresh air, and that this barrier of ignorance always stands as an obstacle in the way of keeping the air in cars reasonably pure. The Massachusetts Commissioners say that "the present lack of uniformity in temperature (in steam-heated cars) is due partly to the fact that the employés have not yet learned to use the existing appliances for regulation to the best advantage, and partly to the failure to provide means for restricting the circulation to a portion only of the piping whenever it is desirable to do so." Even with abundant means of regulating the heat cars will not be properly warmed and ventilated unless the trainmen are properly instructed and rigidly disciplined in its use.

To the objection of the cost of heating with steam from the locomotive, the Commissioners express the belief that it will prove to be more economical than other methods of heating. Whether it is or not will perhaps have very little weight in the consideration of the question, as the public will not consent to have persons burned to death occasionally because railroad companies can save money by assuming that risk.

Another objection to heating with steam from the locomotive which is considered by the Commissioners, is that it is more dangerous than some of the individual heater systems. To throw light on this question, the Commissioners had a series of experiments made to ascertain the effect of the accidental discharge into a car of steam from the heater pipes. Pipes were arranged with valves so that they could be opened at once to their full extent. Even with a pressure of 80 lbs. it was found that there was no danger of being scalded, unless a person's body was in the direct line of the escaping steam and within from three to five feet of the orifice.

The Commissioners conclude this portion of their report with the remark that "locomotive steam-heating has now acquired such a foothold that it will probably come gradually into general use without compulsory legislation."

CAR WHEELS.

An important element, the Commissioners say, in the disaster which occurred at Bradford, on the Boston & Maine Railroad, in January, 1888, was the breaking of a cast-iron wheel. This fact has led them to investigate the relative safety and cost of chilled cast-iron and steel-tired wheels for passenger trains, and the special report on this accident contains a good deal of testimony and data bearing on this question. Much of this is of a contradictory character, and the inquirer for information will be quite sure to be in a confused state of mind with reference to the relative cost and safety of cast-iron and steel-tired wheels, when he has finished reading the report. In fact, the attitude of the Commissioners in relation to it seems to be like that of a gentleman in a Southern city "before the war" who was asked a question about slavery, and answered that he knew little or nothing about it, and was always afraid to investigate it for fear that in doing so he would get into a terrible state of excitement. The Commissioners, after carrying their investigations to a certain point, seemed to have entertained a somewhat similar apprehension to our Southern friend. They say that their "investigation showed that in purchasing cast-iron wheels it is necessary that they should be required to conform to stringent specifications and should be subjected to searching tests," which is undoubtedly a sound conclusion; but their observation that "statistics *seem* to prove that the best of steel-tired wheels are safer than the best of cast-iron wheels," does not seem to have quite as firm a foundation to rest on. Statistics which only *seem* to prove are a very uncertain and sometimes dangerous reliance. The Commissioners quote letters from prominent railroad men with reference to this subject. Mr. Ely, of Altoona, re-

ports an average of one broken cast-iron wheel in a thousand under passenger cars in 1887. Mr. Wallace, of the Grand Trunk, reports two accidents from the failure of wrought-iron wheels, with 3,188 wheels in service. Whether this covers a period of one year or more, or whether the fracture of tires is included is not stated. Mr. Rhodes reports 296 steel-tired wheels in service and two failures in 1887—one of which derailed a train—or one failure to every 193 wheels, and he also reports 2,680 cast-iron wheels in use under passenger cars, *none of which were removed during* 1887 *on account of being broken.* The Pullman Company report that they have over 11,000 steel-tired wheels in service. They do not give the number of failures of wheels or tires, but say that very few tires have broken in service during the years that such wheels have been used, and that in some cases a car with a broken wheel was able to travel several miles without derailment or damage to the car. The Atchison, Topeka & Santa Fé Railroad report eight failures of steel-tired wheels in 1887. The number in use is not given. The Boston & Maine report 550 steel-tired wheels, in use in 1887 and none broken, and 3,478 chilled wheels, of which 18 were found to be cracked or broken. The Grand Trunk Railway report that 8 per cent. of the cast-iron wheels under passenger cars and 2 per cent. under freight cars were discarded for breakages or cracks during the past year.

Mr. Barr, of the Chicago, Milwaukee & St. Paul Railway, says "My experience, as a matter of record both on this road and on the Pennsylvania road, is that steel-tired wheels are more liable to break than good cast-iron wheels. On the Milwaukee & St. Paul Railway during 1887 we had 25 steel-tired wheels fail from breakage, and 50 cast-iron wheels. These numbers are just about proportionate to the number of steel-tired and cast-iron wheels running. In January, 1888, we had 11 steel-tired and eight cast-iron wheels break."

It will thus be seen that these statistics are very far from being conclusive with reference to the relative safety of cast-iron and steel-tired wheels.

Regarding the relative cost of the wheels the evidence cited by the Commissioners is also ambiguous. Mr. Ely makes an estimate in which he shows that cast-iron wheels which make an average mileage of 42,522 cost 14.5 cents per thousand miles run, whereas steel-tired wheels, with an average of 250,000 miles, cost 24 cents per thousand miles. This he says is more than they have been able to get on the Pennsylvania road. Mr. Wallace reports an average of only 162,000 miles, and this average includes many 43-in. wheels. The Pullman Company report an average mileage of 340,843, chiefly 42-in. wheels, and 335,670 miles for 33-in. wheels.

From these data it will be seen that the testimony quoted by the Commissioners does not "*seem*" to prove much of anything, with reference to the relative safety and economy of steel-tired and cast-iron wheels, excepting that some more conclusive data are needed to guide both the Railroad Commissioners and railroad officers.

The Report before us is full of other interesting matter, but our limit of space for its consideration has been reached and further discussion of it must be relinquished, at least for the present.

RAILROADS AND THEIR EMPLOYÉS.

THE article on the Prevention of Railroad Strikes, by Mr. Charles Francis Adams, which is published in the April number of *Scribner's Magazine*, will doubtless attract much attention from railroad men, not only from the suggestions which it makes in relation to the railroad service, but also from Mr. Adams's position as President of the Union Pacific Company, and from the reputation as a thinker and a writer on railroad matters, which he gained during his long period of service on the Massachusetts Commission. The article itself is mainly a reproduction of a memorandum which Mr. Adams prepared for the Union Pacific Company some three years ago, but which was never acted upon or made public. While drawn up with special reference to the circumstances of that Company, it nevertheless contains much which is applicable to all large corporations.

The organization of the service proposed in this article is intended to do away with the evils resulting from the present shifting and transitory character of the force on most of our roads, and to provide for a permanency and a strictness of discipline which is almost impossible under present conditions. To this end Mr. Adams proposes, on the one hand, to offer such inducements as will prevent the railroad employé from quitting a road for slight cause—or for no cause at all—and, on the other hand, to secure him in his position by taking away the power of arbitrary dismissal, which is now very generally vested in Superintendents and other officers. Incidentally, he believes that this plan would remove much of the friction now existing, and would put an end to trades-unions, by practically depriving them of any reason for existence.

Space will not permit a full summary here, but it may be said that it is the plan in use on the great French railroads, of a permanent service with graduated promotion and gradual increase of pay with length of service, provision being made also for temporary employment, which shall serve as a probationary term and provide an auxiliary force from which appointments shall be made to the permanent service. Incidentally, or rather, perhaps, as a result, he would provide insurance funds for employés and schools of apprenticeship in which young men should be educated for the service.

The main points of this system are that every employé should feel himself secure in his position during good behavior, and also sure of such promotion or increase of pay as his length of service, capacity, and improvement may justify. To modify this French system and bring it more into accordance with American ideas, he proposes to add a council composed of delegates chosen by the employés, who should represent them in their dealings with the company, should act as advisors in all matters in which they are concerned, and should also serve, in connection with officers of the company, as a tribunal for the trial of all offenders against the rules of the road; and he would give to every one a right of appeal to this tribunal before he could be dismissed from the service. He would also, in working out the details of his plan, provide for somewhat more freedom of action than the French system allows, believing this to be necessary in order to deal properly with the class of men here employed, who are usually much more independent and accustomed to think and act for themselves than the French employés.

Undoubtedly many arguments can be presented in favor of such a system, and it is at least worth careful study. A partly similar organization has for years been in use by one or two of the larger Eastern Companies, with results which must be admitted to be generally good. At the same time, it must be remembered that there is always

great difficulty in making such a system sufficiently elastic, and that there is always danger of its becoming a mere beaureaucracy, the inevitable tendency of which is to suppress exceptional ability and to keep everything at a uniform level of mediocrity.

A railroad company, or its executive head, should be left free to recognize ability and to reward it by promotion out of the usual course in its own service, and provision should be made against the tendency—which always exists in a permanent force—to become a close corporation, which, whatever jealousies may exist among its individual members, will always unite to oppose exceptional promotion or the appointment of officers from outside its own number. Permanency of service is certainly very much to be desired on our railroads, but how to combine it with the proper degree of freedom of action in appointments is a study which needs and ought to receive careful attention from managers.

In one point Mr. Adams is certainly right, and that is in claiming that proper discipline is not only possible under the proposed conditions, but more easily obtained than at present, and in insisting upon the right of an employé to protection against arbitrary discharge, and to a recognition of the claims upon a company, which he establishes by faithfulness and diligence in any position, high or low. This is essential to any lasting adjustment of the question, and a full recognition of the principle would go far toward improving present relations.

RECLAIMING BARREN LANDS.

ONE of the most notable public works of recent times has been the reclamation of the extensive district known as the Landes of Gascony by French engineers, at whose head was M. Chambrelent. This district, including an area of about 800,000 hectares (1,980,000 acres), had been for centuries regarded as a worthless desert, not only unavailable for agriculture, but extremely unhealthy on account of the malarial exhalations at certain seasons of the year, and of the absence of any supply of good drinking water.

Efforts had been made at various times to improve this district—notably in the early part of the present century—but they had all proved disastrous failures, and it was not without much difficulty that M. Chambrelent secured a trial for his plan.

The general surface of the Landes is nearly level and the soil was a silicious sand, entirely destitute of any mixture of lime or clay, resting upon a subsoil of clay or hardpan impervious to water. The rains of winter did not drain off, but remained in swampy pools, filling the slight irregularities of the plain ; and these surface waters evaporated under the sun of early summer, leaving the sandy soil entirely dry under the heat of July and August. What little vegetation could start up around the pools in the early spring was dried and burned up in the summer, the roots finding no reserve of moisture in the loose sand, and being unable to penetrate the hard clay below.

The methods adopted to reclaim this district, though only selected after a careful study extending over several years, were really very simple. They consisted first, of the establishment of a system of surface drainage by means of shallow ditches, intended not so much to draw off all the rain water as to equalize its distribution ; and second, of the planting of forests of pine-trees, which are known to grow well in a sandy soil.

The work proceeded slowly, of course, being at first largely experimental in its nature. It was found, however, as it advanced, that the trees from the seed first planted grew and throve in an unexpected way, while their spreading roots not only consolidated the loose sand and held in it a reserve of moisture—which had formerly been evaporated, but which now served to supply the growing trees—but also, apparently, broke up and penetrated the underlying hardpan, drawing nourishment from it also as the trees increased in size.

So successful were the first experiments that the work was pushed forward faster and faster until the whole district is now reclaimed, and from a worthless desert has become one of the most prosperous parts of France.

Two subordinate but still important works were found necessary. The first was to provide a supply of drinking water for the men and animals engaged in the work and for the population which was expected to follow its completion. This problem, fortunately, was easily solved by sinking wells to a moderate depth ; these wells yielded a supply of water of good quality and sufficient in quantity for all requirements.

The second was to prevent the continued encroachment on the reclaimed lands of the shifting sand-dunes which formed on the sea-shore of the district, and which, under the influence of the prevailing winds, were constantly moving inland. After much study and experiment this was accomplished by the use of what might be called temporary sand-fences, by which the sand-dunes were not only checked in their movement, but also, as it were, reversed and made to form a barrier against any further encroachments from the sea.

Financially the operation has been highly successful. The Landes were nearly all owned by the surrounding *Communes* (or townships), having too little value to invite purchase or settlement by private owners. The funds for beginning the work were provided by these *Communes*, under a special law ; as it advanced the reclaimed land was sold at prices which not only paid for the work but provided funds for building roads and school houses and for making many other improvements.

The district is now intersected by several railroad lines, which find a considerable traffic in carrying the lumber which is yearly cut from the growing plantations. Not only is lumber supplied, but large quantities of charcoal and firewood—both scarce articles in France—are shipped to Paris and other cities, and many thousand ties are yearly supplied to the railroads. It need hardly be said that the cutting of trees is carefully regulated and provision is made for renewing the growth.

The Landes under this treatment have not only become valuable, but their sanitary character has been completely changed. The few inhabitants were formerly constant sufferers from malarial diseases, but now, with a largely increased population, such diseases have disappeared, and the average health of the whole district is considerably above that of the average of all the rural *Communes* of France. This result is ascribed by the local physicians to the good surface drainage, the sea winds, and the neighborhood of the pine forests, as well as to the usually good sanitary condition of the dwellings, resulting from the general prosperity of the people.

The whole history of the reclamation of the Landes is worthy of study by engineers in this country, where the time is fast approaching when the increasing value of land will make it profitable to undertake similar operations.

NEW PUBLICATIONS.

CATALOGUE OF THE MINERALS AND WOODS OF THE REGIONS TRAVERSED BY THE LINES OF THE RICHMOND & DANVILLE RAILROAD COMPANY. Richmond, Va.; issued by the Company.

This is a catalogue of the exhibits made by the Richmond & Danville Railroad Company at Atlanta, 1881; Boston, 1882; Denver, 1883; New Orleans, 1884; Atlanta again, 1887, and at Richmond in 1889. These exhibits include specimens of the mineral products found on or near the company's lines in Virginia, North Carolina, South Carolina, and Georgia, and of the various kinds of woods from trees growing in the same districts.

The minerals cover a wide range, including ores of gold, copper, iron, manganese, tin, and many less known metals; coal, mica, building stone of many kinds, and a long list of other useful minerals. Most of these deposits are still but little developed.

The list of native woods shows a great variety of useful and valuable timber. Such an exhibit is a very valuable one, both to the railroad and to the community which it serves, and the Richmond & Danville Company deserves credit for the care with which its collections were made.

THE COAL TRADE: BY FREDERICK E. SAWARD. New York; published by the Author.

This is the sixteenth issue of a very valuable statistical annual, the only one, in fact, which gives the coal production and distribution of the United States with anything approaching to completeness, or in convenient form. Entire accuracy or completeness is, unfortunately, not possible under our present system, but Mr. Saward's long experience as Editor of the *Coal Trade Journal* has given him a thorough knowledge of the trade and of the sources from which the most reliable information is to be obtained—a very great advantage in preparing a manual of this kind.

The coal industry is of so much importance in itself, and is so closly related not only to all other industries, but also to daily household life, that its condition and development must be of interest to almost every one; and nowhere can it be better studied than in the successive issues of this annual. For the use of any one engaged in the trade as operator or dealer it seems almost indispensable.

STEAM: ITS GENERATION AND USE. New York; issued by the Babcock & Wilcox Company.

This is a new edition of the catalogue of the manufactures of the Babcock & Wilcox Company, and deserves especial mention for the care with which it has been prepared and the elegance of its mechanical execution. It is, of course, intended to set forth the merits of the Babcock & Wilcox boiler, but it contains also much useful and valuable information on steam, combustion, and kindred topics. The illustrations are of the best, while the printing and binding of the book are admirable specimens of American work.

A TREATISE ON HYDRAULICS: BY MANSFIELD MERRIMAN, PROFESSOR OF CIVIL ENGINEERING IN LEHIGH UNIVERSITY. New York; John Wiley & Sons, No. 15 Astor Place (price, $3.50).

In this book Professor Merriman has undertaken to give a summary of our present knowledge on this subject, which shall at once be comprehensive and compact in form, and which may serve as a book of reference for engineers as well as a text-book for students. In these objects he has succeeded very well, and his book will not only be a valuable addition to the literature of the subject, but will doubtless become a standard work. It not only gives the accepted formulæ with some new ones and many modifications, but also the reasons for these formulæ and some account of the experiments upon which they are based.

The different chapter headings include: Hydrostatics; Theoretical Hydraulics; Flow through Orifices; Flow over Weirs; Flow through Tubes; Flow in Pipes; Flow in Conduits and Canals; Flow in Rivers; Measurement of Water-power; Dynamic Pressure of Flowing Water; Hydraulic Motors, and Naval Hydromechanics.

It is accompanied by a number of tables, calculated from the formulæ given, which are very convenient for reference. It is written in the clear and exact style which we are accustomed to expect from Professor Merriman, and contains little or nothing that can be called superfluous.

OUR RAILROADS: BY HARRY P. ROBINSON. *Being a Presentation of Facts and Figures showing the Value, Earnings, Profits, and Present Condition of the Railroads of Minnesota and the Northwest.* St. Paul, Minn.; Published by the Author.

This pamphlet, the author of which is editor of the *Northwestern Railroader*, presents a great array of statistics, the object of which is, apparently, to show that the railroads of Minnesota and the adjoining States are generally earning, under existing conditions, much less than a fair return upon the capital invested in them. He illustrates, in a somewhat striking way, the great reduction in rates which has taken place during the past few years, with some of the causes which has tended to produce this result, and argues against the policy of any further reduction. According to Mr. Robinson's figures, while Minnesota railroads are, on the average, capitalized at a somewhat lower figure than those of most of the States, their earnings per mile, both gross and net, are also considerably below the average for the whole country. Whatever opinion we may have as to the justice of his conclusions, we must admit that the author has presented his arguments both clearly and forcibly, and his pamphlet is well worth careful reading.

A GENERAL FORMULA FOR THE UNIFORM FLOW OF WATERS IN RIVERS AND OTHER CHANNELS: BY E. GANGUILLET AND W. R. KUTTER; TRANSLATED BY RUDOLPH HERING AND JOHN C. TRAUTWINE, JR. *With numerous additions, including Tables, Diagrams, and the Elements of over* 1,200 *Gaugings of Rivers, Small Channels, and Pipes.* New York; John Wiley & Sons, No. 15 Astor Place (price, $4).

This treatise was translated some eight years ago, and as since then the correctness of the formula has led to its very general adoption by Hydraulicians, a demand for such a book as this, has been, in the opinions of the translators, created which has led to the present publication in octavo form, containing not only the translation of the original treatise, but an addition in the shape of appendices which in many respects are of more value even than the main part of the book.

Part I contains a short historical account of the different formulas that have been used, down to the establishment of Bazin's formula, based upon the measurement of Eu-

ropean waterways of small area and steep slopes, and Humphrey's and Abbot's new American formula, based principally upon gaugings of the Mississippi River.

The manner in which these two formulæ fail, as a general formula applicable to all probable conditions, is clearly shown, and the problem of a generally applicable formula is clearly stated.

Part II is devoted to a development of a general formula. Comparison of the results obtained by Bazin, Humphrey and Abbott, and the new general formula. Correctness checked by actual gaugings under various circumstances.

This constitutes the book proper. A Supplement of 10 pages contains in concise form most of the essential matter contained in the preceding 93 pages, as to the derivation of the formula.

Appendices give, first, the limitations of the formula, second, some general laws regarding its use, third, coefficient of roughness, fourth, method of computing velocity from the formula, fifth, the construction of diagram and many other points of practical importance. These are followed by about 110 pages of tables to facilitate the use of the Ganguillet and Kutter formula.

The book as a whole is a comprehensive treatise upon the formula that is developed. There is one most excellent feature, aside from the value of its contents, and that is, the free use that has been made of Graphics to bring clearly before the eye the comparative results obtained and show how much of practical work in the use of the formula can be simplified by the use of diagrams and graphic methods. Much of this general use of graphics in this book is undoubtedly due to the translators, who have endeavored to present their subject in as clear and simple a manner as possible, using care not to bury their facts "out of sight under heaps of mathematical rubbish," as is too often the case in books of this class.

TWENTIETH ANNUAL REPORT OF THE MASSACHUSETTS RAILROAD COMMISSIONERS: 1888. Boston, Mass.; State Printers.

The Report of the Massachusetts Railroad Commission this year treats of the usual variety of subjects, and has much to say of the experience gained during the year in continuous heating of passenger trains. The Commissioners now believe that continuous heating by steam from the locomotive has acquired such a foothold that it will probably come into general use.

Other special subjects touched on are grade-crossings, car-wheels, switches and couplers, and there is also an interesting report on the railroad bridges of the State.

STATISTICS OF THE AMERICAN AND FOREIGN IRON TRADES FOR 1888. ANNUAL STATISTICAL REPORT OF THE AMERICAN IRON AND STEEL ASSOCIATION: *Containing Complete Statistics of the American Trade for* 1888, *Compared with* 1887, *and a Brief Review of the Present Condition of the Iron Industry in Foreign Countries.* Philadelphia; Published by the American Iron & Steel Association.

This report, as usual, contains full statements of the production of iron ore, pig iron, finished iron and steel in the United States, with tables of prices, values, etc. It is the only publication of the kind in this country giving these statements with an approach to official accuracy, and the long experience of Mr. Swank, Secretary of the Association, in preparing these reports, has enabled him to present the statistics in a very compact and convenient shape. The report is issued this year more promptly than usual, which is an advantage, accompanied only by the slight drawback that, owing to this early publication, the review of the foreign iron trade is briefer than usual.

An interesting appendix gives a list of the new vessels now under construction and authorized for the Navy, with some account of the new guns under construction, the object being to show the demand for steel for Government purposes.

COAL SUPPLY.

(From the *Evening Post.*)

NOW and then some man of science bolder than his fellows faces the question, "How long will the coal supply last?" The late Professor Jevons undertook to answer it for England twenty-four years ago, and made himself extremely unpopular for a time. According to his computation, the supply would be exhausted in 110 years. Sir William Armstrong had previously calculated that all the coal within 4,000 ft. of the surface would be exhausted in 212 years from 1861. Professor Marshall of Yorkshire College examined the question in 1878, and confirmed in substance the conclusions of Professor Jevons, but added some facts to show that a very slight difficulty in the procuring of coal, causing an enhancement of price, would revolutionize British industry and cause dire distress to her teeming population. And now Mr. Price Williams has presented a paper to the Royal Statistical Society in which he estimates the duration of the principal English coal fields at the present and prospective rate of consumption, thus:

	No. of Years.
Northumberland and Durham	94
South Wales	79
" " Eastern division	46
Lancashire and Cheshire	74
Yorkshire, Derbyshire and Nottingham	90
Warwickshire	53
Denbighshire and Flintshire	250
Scotland	92
United Kingdom	102

Although coal has been used more or less as fuel in Great Britain from a very early period, perhaps from the time of the Roman occupation, the total production of the United Kingdom did not reach 10,000,000 tons per annum until the beginning of the present century. We may say, therefore, that no perceptible draft had been made upon the stock prior to the year 1800. During the next 50 years the increase of consumption was moderate, reaching only 52,000,000 tons in the year 1852. From that time onward the rise has been by leaps and bounds. In 1866 the output was 101,000,000 tons, in 1883 it had reached 160,000,000 tons, and it has increased since that time at the rate of 1¾ per cent. per annum. If Mr. Price Williams's computations are to be accepted as correct—and they coincide remarkably with those of Jevons and Marshall—it will appear that a period of 191 years, beginning with the year 1800, will have sufficed to disembowel the United Kingdom of that element of wealth and power to which she owes her present greatness, and in comparison with which all other elements are trivial and insignificant. When her coal is gone, there will be no more Great Britain. Empire will pass out of her hands into those of countries better supplied with this indispensable article, and so, according to our present knowledge, will empire shift her seat through coming ages from one country to another until all are reduced to the common level of want, for all coal-beds are exhaustible. The Reading Railroad Company, which owns or controls one-third of the anthracite deposits of Pennsylvania, has estimated the duration of its supply at about 150 years, and has deemed it necessary to create a sinking fund to meet the exigency.

Up to this time nobody has ventured to say what fate will overtake the human race when all the coal is consumed and gone. Of course economies will be introduced. More power will be got out of a given amount of coal.

Great economies have been introduced, but the annual draft on the mines increases from year to year. The annual draft increased in England at the rate of 3 per cent. per annum from 1865 to 1875. It has been reduced to 1¼ per cent., but it is an increase still. More tons are required every year than the year before. Natural gas, petroleum, and shale, where they exist, will serve the turn to eke out the coal supply, but these, too, are exhaustible. They are all scraps of the sun's radiant energy, imprisoned by chance or by Divine Providence in the earth's shell. They are, all told, but a fraction of the radiant energy which the sun pours over the earth every day, and this is an inappreciable fraction of what the sun pours into illimitable space. Will the genius of man ever contrive means to capture and impound the fraction which our globe intercepts as it rushes through sun-lit space? Here is the greatest question ever presented to the human species, for unless this feat be accomplished, population must eventually be reduced to the number who can be supplied with fuel from the cultivation of trees. Power may be obtained from falling water and from the ocean tides, and this may be converted into heat; but it is a pitiful and poor substitute for coal, and would not begin to maintain the world's present population in the present scale of civilization and comfort.

The prize of greatest magnitude ever offered to men of science—the honor of rescuing the entire race from misery unspeakable—awaits the man or men who shall grasp, and hold, and render serviceable the rays of the all-powerful sun. No one can say that this problem will not be solved. We now know that light and heat are manifestations of one and the same thing. We know that light is abundant and superabundant. We do not know whether it can be concentrated and converted into heat so as to take the place of coal in the economies of the world. According to our present knowledge, we are living in the world's golden age. Those who went before us knew not the civilization that we enjoy, because they knew not the uses of coal. Those who follow us, after the coal is burned up and gone, will have to resign that civilization—a much harder fate than never to have known it—unless the great sun problem can be solved. Nobody who is now alive need concern himself with that hard destiny, but in the history of the planet, even the written history, the age of coal will be comparatively a short one.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 161.*)

IV.—EARLY GUN CONSTRUCTION.

When at Kinburn, on October 17, 1855, the round shot from the Russian batteries broke to pieces or rattled harmlessly against the iron plating of the three French armor-clad floating batteries, they sounded the doom of smooth-bore ordnance. From that hour to the present the battle between the gun and the armor-plate has been going on with fluctuating advantage. In the contest the 24-pounder of the Russian has grown to the 120-ton monster of Krupp; and the 4½ in. of wrought-iron armor of the *Devastation* has increased to the 22 in. of steel of the *Duilió*, and the battle is still on, but with strong indications that the final victory will remain with the rifle, where it is to-day.

Before the necessity of rifled ordnance had been so thoroughly demonstrated at Kinburn, experiments in this direction had already begun. About the time when the adoption of rifled small-arms for the military service had been decided upon (1840), the question of rifled cannon was taken up by artillerists. In 1846, Major Cavalli, a Sardinian officer, invented a breech-loading rifled cannon. It was of cast iron, 16 calibers in length, 66 cwt., with a caliber of a little over 6 in. Two deep spiral grooves, with a twist equal to twice the length of the bore, served to give rotation to the projectile. In the same year Baron Wahrendorf invented another breech-loading rifle of about the same caliber, of which no details are given.

Neither of these systems seem to have gained a foothold, and are mentioned as the first decided steps looking toward the improvement of heavy guns. At this time the heavy ordnance of the period were 32, 42, and 68-pounders, or pieces corresponding to about these calibers.

In 1854 Mr. William Armstrong submitted to the English War Minister proposals for a rifled breech-loading field gun. The gun was completed the following year, and after a long series of experiments, extending over several years, was finally adopted into the English service in 1859.

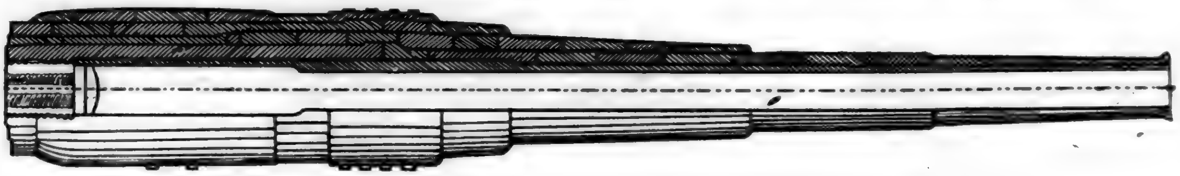


Fig. 1.

The first rifled ordnance, however, to receive trial in actual warfare were the so-called Lancaster guns, in the Crimea, in 1854–55. These were 68-pounder cast-iron pieces, rifled on Mr. Lancaster's system, and strengthened with bands of wrought iron. Rotation was secured by giving the bore the form of a twisted ellipse, the projectile, of course, having a corresponding shape. The spiral made one turn in four times the length of the bore, with the greater axis in a vertical plane at the muzzle section and becoming horizontal at the breech section.

The English experiments with these guns in the Crimea were not satisfactory. They failed in the very direction wherein rifled guns are supposed to possess advantages over smooth-bore pieces—accuracy and penetration. At Bormasund the *Edinburgh* attempted to breach masonry at 480 yards. The firing was wild, and the 100-pound projectiles had no effect upon the granite walls.

V.—THE ENGLISH SYSTEM.

The Armstrong gun just alluded to was the first venture in the direction of "built-up" rifled artillery, which has to-day become the almost universal method of gun construction.

The first guns made by Armstrong were composed wholly of wrought iron. The material in long bars, varying in section with the size of the gun, was coiled into spiral tubes two to three feet in length and welded by forging, the tubes themselves being afterward united end to end by welded joints. Behind the trunnions and over the seat of the charge two additional layers of metal were applied. But to obtain longitudinal strength and to sustain the backward thrust on the breech, the second layer was made of an iron slab bent in cylindrical form and welded at the edges, the fiber of the iron being in the direction of the length.

The defects of this method of construction soon became apparent. Small cracks or defective welds would often make their appearance after a few rounds, the welded edges of the spiral sometimes pulled apart, while the repealed shock of discharge had a tendency to produce permanent "set" in the metal. This led to the adoption of what is known as the Fraser modification of the Armstrong system—the substitution of a thin steel lining for the wrought-iron inner tube, surrounded by successive layers of wrought-iron coils or cylinders, the number increasing with the caliber of the gun. The details of con-

struction in the English system—Woolwich and Armstrong—have varied somewhat at different periods, but essentially the method of "building up" the gun has been the same—the shrinking upon an inner coil of wrought iron or tube of steel, forming the bore of hollow cylinders of wrought iron, varying in number with the size of the piece. In guns of latest construction steel only is employed. Fig. 1 is an example of this construction.

In this principle of *shrinkage* may be said to lie the possibilities of the high-power rifle, and it deserves a word of explanation. In a mass of solid, homogeneous metal, as the body of a cast gun, when subjected to sudden and severe pressure, like the explosion of a charge of gunpowder, the metal immediately surrounding the bore is called upon to bear the brunt of the strain, and before the reserve strength of the outer portions can be brought up to its assistance, the elastic limit is passed and rupture takes place. Hence, in guns of this character, beyond a very moderate limit, no additional thickness of metal adds to their strength.

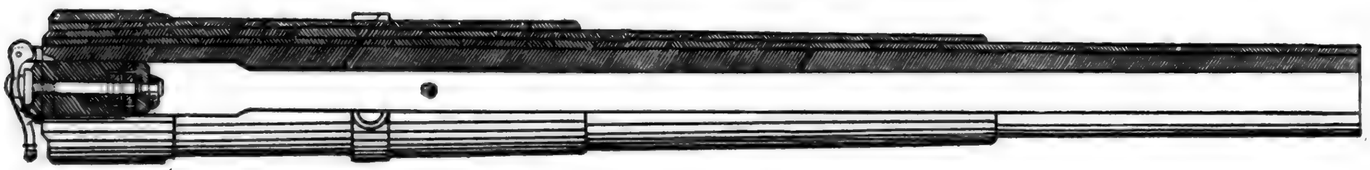


Fig. 2. De Bang 34-centimeter gun.

With a built-up gun the conditions are different. The inner tube, forming the bore, is of sufficient thickness to bear the first shock of discharge. The second tube or cylinder is carefully bored, so that its interior diameter when cold is slightly smaller than the exterior diameter of the inner tube. A moderate degree of heat will expand this outer tube, so that it can be easily slipped over the inner one. Upon cooling it shrinks and compresses the inner tube, which is then in what is called a state of "initial tension" or compression. The difference in the diameters of the two tubes regulates the degree of compression. The resistance offered by the inner tube causes the outer one to stretch somewhat in cooling, which is then in a state of extension. If, now, we shrink upon these two tubes a third, in the same manner, a strain of compression is brought upon the second, the degree of which will be measured by its compression minus its previous extension. Were a fourth and a fifth tube to be shrunk on in the same way, the same strains would be brought into play, the compression of the inner tube would be greater than the second, the second than the third, and so on. The last layer would be under the strain of extension only.

A gun whose metal is in this state of tension is in condition to transmit very quickly strains from the inner to the outer coils, thus bringing into play the entire strength of the metal. Especially with slow-burning powders, can this aggregate strength of the gun be brought to bear to resist rupture. With the inner tube or layer of metal in a state of initial tension, it can endure without rupture a strain quite double that of its normal elastic limit.

It might be mentioned here that the two English systems of gun construction—known as the Woolwich and Elswick—follow essentially the same lines; the former being the works of the Royal Gun Factory, the latter those of Sir William Armstrong.

Following closely in the lead of Armstrong, Joseph Whitworth, an English metallurgist, began, toward the end of the fifties, the construction of rifled breech-loading ordnance. Instead, however, of employing wrought iron he used forged cast steel; but in his manner of building up his guns followed the general methods of Armstrong. It is now a well-defined system, differing in several important particulars from the methods employed at Woolwich and Elswick. The steel of which his guns are made instead of being forged in the usual way, is, while in a semi-fluid state, compressed by powerful hydraulic machinery. Hydraulic pressure is likewise employed to assemble the parts. The inner tube has a slight taper toward the breech, and over this is forced the first hoop—the degree of tension being determined, of course, by the amount of taper. A second, a third, and in the larger calibers, a fourth hoop, formed like the first, is forced on. The last hoop carries the trunnions.

The advantages claimed for the Whitworth method of forging by compression are that it leaves the metal with a more uniform molecular structure, that the solidification of the metal is more perfect, and the mass more homogeneous throughout than where the ingot is subjected to long-continued and probably unequal hammering at different points. Very likely the great care exercised in the selection of the metal and in its manipulation during the process of casting, have quite as much to do with the high quality of the metal as this special method of forging. At any rate its superiority is not undisputed among metallurgists.

To Whitworth belongs the credit of having first demonstrated the ability of rifled projectiles of moderate caliber to pierce armor-plates of considerable thickness. As early as 1860 a Whitworth gun, with an 80-pound solid steel shot, perforated for the first time a 4.72-in. plate, and later, with his 7-in. 7½-ton gun and a 150-pound shell, he perforated the so-called *Warrior* target (4.49 in. of wrought iron backed by 18 in. of teak). Whitworth compensated for the small caliber of his shot by increasing their length (three calibers, which at that time was an unusual length), and by making them of steel. As has been said, Whitworth was in advance of his age, and not only this, it may be added that the deserved success he has since obtained has been in spite of the powerful opposition or competition of both Armstrong and the Woolwich people. The English Government would have saved itself millions of pounds had it, in 1859–60, followed the lead of Whitworth with his steel rather than that of Armstrong with his wrought iron.

VI.—FRENCH SYSTEM.

The French Government began the construction of rifled guns in 1855, upon the plan, as has been stated in a previous article, of utilizing its cast-iron ordnance. The first essay was with cast iron muzzle-loading pieces, unbanded, of about the caliber of a 32-pounder. The results obtained were not satisfactory, and four years later two 6.3-in. all-steel, banded, breech-loading experimental guns were constructed. The first experiments with these guns were highly satisfactory, but later the attempt to use excessive charges of quick-burning powder brought them to grief, discredited steel as a gun metal, and confirmed the belief in cast iron.

From 1860 to 1875 France devoted her attention to cast-iron guns, reinforced in various ways with steel hoops and a steel lining for the bore. At the latter date all-steel built-up guns were constructed, and since that time steel has monopolized the field.

The French heavy guns are built up of a hammered steel tube and four rows of steel hoops. In the 34-cm. gun, the first row extends the whole length of the piece; the second, to the middle of the chase; the third, to in front of the trunnions, while the fourth is made up of three breech hoops and a trunnion ring. To secure additional longitudinal strength the hoops are made with a slight double-taper, as shown in the accompanying cut (fig. 2), in which, however, the taper is considerably exaggerated.

In France, open-hearth steel is used in gun construction. The rough forgings for the tubes and hoops are procured from private foundries, and assembled at the Government works at Creuzot and Saint-Chamond.

(TO BE CONTINUED.)

THE GAGNIERES VIADUCT.

(From the *Revue Generale des Chemins de Fer.*)

NEAR the Gagnieres station on the single-track line from Pouzin to Alais, the valley of the little river Gagnieres is crossed by a masonry viaduct, the piers of which are on land belonging to the Gagnieres Coal Company.

This viaduct was built in 1871 and consists of 13 arches each of 12 meters (39.37 ft.) span, the maximum height being 24 meters (78.74 ft.); the total length is 215 meters (704.20 ft.), on a curve of 300 meters (984 ft.) radius. At that point there is a uniform grade of 1 per cent.

In consequence of sinking in the foundations of some of the arches, shown by the appearance of cracks in the masonry, since the working of the coal-mines began in 1879, the Paris, Lyons & Mediterranean Railroad Company decided to abandon the existing viaduct, the safety of which was threatened by the subterranean working of the mines.

To replace it a new viaduct has been built having a total length of 167 meters (547.76 ft.) between the abutments, with three independent spans, each having 52 meters (170.56 ft.) opening between the masonry piers or abutments. These three spans are all alike in length and in all their details.

The new viaduct is above the old one; it is on a straight line, following the chord of the arc described by the old bridge.

The new structure is a deck-bridge, carrying the floor on the upper chord; the depths of the trusses is 3.900 meters (12.8 ft.) and they are spaced 3.550 meters (11.64 ft.) between centers. They rest upon two piers and upon the two abutments, the surface of the masonry being 4.114 meters (13.5 ft.) below the top of the rail.

The piers and abutments are of stone in regular courses, with a large area at top, the surface of the masonry extending 1 meter (3.28 ft.) in each direction beyond the seats for the trusses; all are built with a batter of 1 in 10 on all faces, and rest on a bed of beton, which is founded on the bed-rock and extends at least a meter in every direction beyond the lowest course of stone.

Under these conditions, in case any movement of the piers or abutments should take place, it will be easy to find a remedy, by taking advantage of the large area provided in the foundations.

The metallic spans are also arranged in such a way that they can be adjusted in case of any sinking of the masonry. Each span, being independent of the others, can be raised at either or both ends to counteract any inequalities resulting from possible settlement of a pier.

The girders of the three spans are supported at each end on cast-iron seats or sockets resting on steel rollers, by which the weight is distributed evenly over the pier. Moreover, the construction of these seats is such that they can be raised, if necessary.

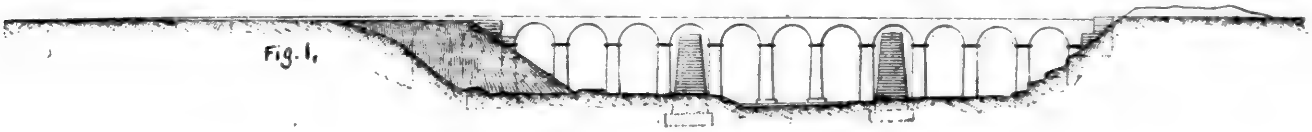
In the accompanying illustrations fig. 1 is an elevation of the old viaduct, showing also the piers and abutments of the new bridge; fig. 2 is a plan showing the location of the old and the new viaducts; fig. 3 is an elevation; fig. 4, a plan of one span of the new viaduct; fig. 5 is a cross-section of one of the spans on a larger scale.

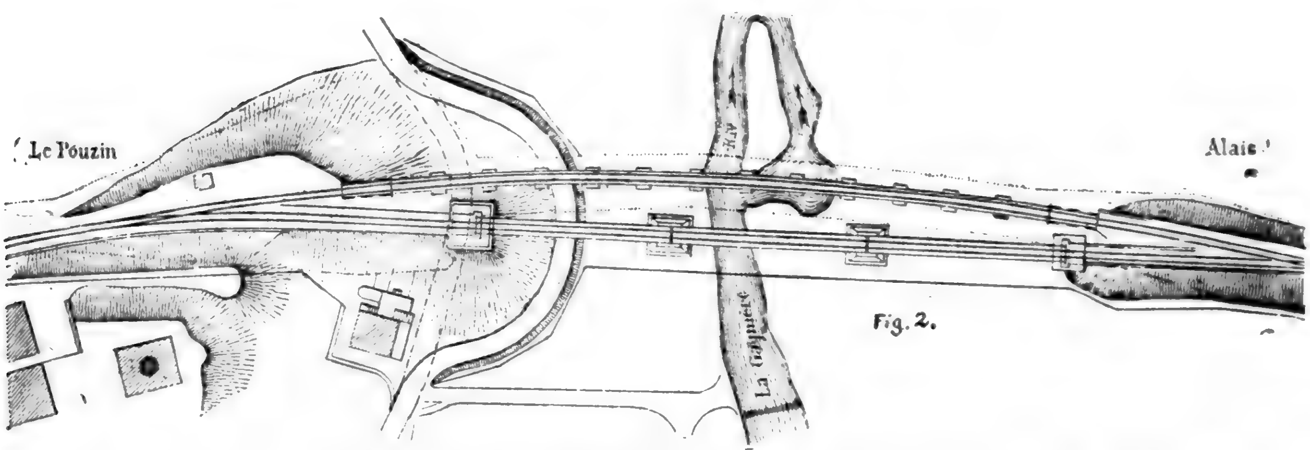
Each of the spans is composed of two simple lattice girders joined above by the floor girders and below by counterbracing. The vertical cross-stays also connect the girders.

Longitudinal strips riveted to the girders and connecting them vertically are carried along the whole length of the span under the rails; longitudinal sleepers of oak held in place by angle iron and bolts serve to carry the rails. Iron brackets fixed to the girders at intervals support a hand railing on each side of the track.

On the abutment the truss, which in the rest of the bridge is composed of channel bars outside and plates inside, is replaced by a full panel with channel bars both outside and inside, placed vertically.

In the rest of the span the girders are braced inside by vertical struts composed of plates and angles; outside and below they are joined by a triangular plate and by angles, at the top of the vertical plate.





Triangular plates of iron of 55 kilogrammes weight per square meter riveted to the trusses and to the longitudinal girders, form counterbraces for the bridge floor.

The principal dimensions of each span are as follows:

Clear opening of each span	52.00 meters	(170.5 ft.)
Total length of girders	57.20 "	(187.6 ")
Width of piers at the top	5.50 "	(18.0 ")
Depth of trusses	3.90 "	(12.8 ")
Distance between centers of girders	3.55 "	(11.6 ")
Length of panels of truss	3.60 "	(11.8 ")
Length of two end panels of truss	3.40 "	(11.2 ")
Distance between centers of hand-rails	4.50 "	(14.7 ")

All plates and other pieces have finished joints, the edges and faces being either planned or filed. The riveting is very carefully done to secure perfect joints; all that was done in the shop was done with a riveting machine except in certain corners and joints which the machine could not reach. The rivet holes were all drilled in such a way as to correspond exactly. The diameter of all the holes was 1 mm. greater than that of the rivets. Drifting out of holes was forbidden, and when after the plates, angles and joint-plates were put in place the holes did not correspond, they were drilled out by hand. Care was taken that the rivets were uniformly heated.

An allowance of one-quarter of a millimeter was made on the dimension of each piece entering into the span.

Each of the three spans was assembled and riveted in its place on wooden false-work 19 meters in medium height, which was used successively for each of the spans. The line of the road back of the abutment did not permit the putting of the bridge together and the lowering into place afterward ; moreover, the spans being independent, such an arrangement would have required the making of a connection between them so as to form a continuous girder, which would have increased the weight considerably.

When the spans were completed they were raised by hydraulic presses and the seat-plates on the piers put in position under them. Lead plates 3 mm. in thickness were placed between the masonry and the cast-iron plates upon which the spans rest.

The material for the bridge was carried to the place where it was needed by a spur track laid from the main track of the railroad, at the level of the top of the abutment.

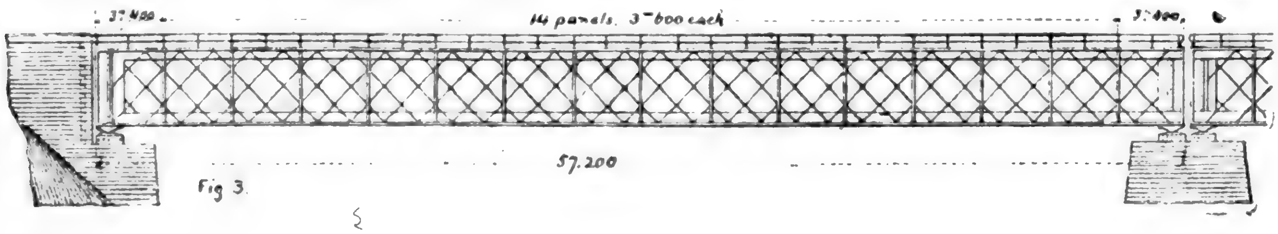
The different conditions governing the adjustment of the plates, the drilling of the holes, and the heating of the rivets at the place of erection were the same as those given above for the work done in the shop.

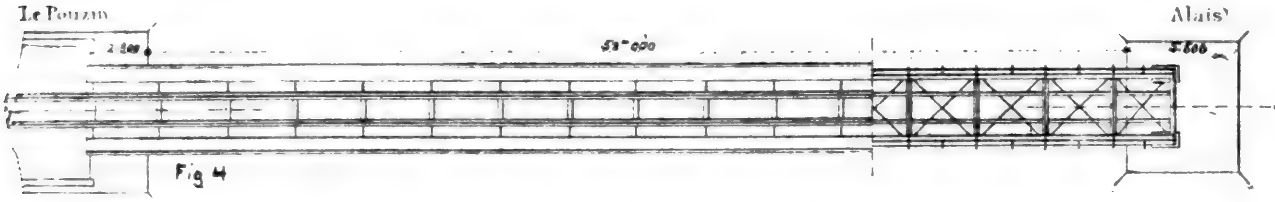
The work was done by the Société des Forges de Franche-Comte, the price for the superstructure, including transportation, erection, and painting, being 34.85 francs per 100 kilogrammes (3.05 cents per lb.).

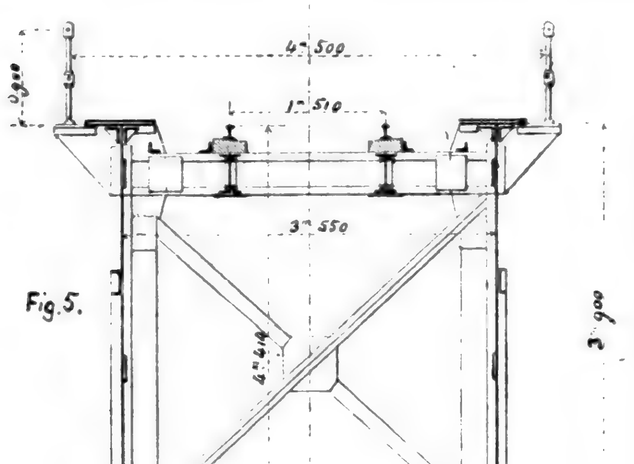
The plates, angles, and channel bars used in the superstructure were of mild steel and the rivets of iron.

In testing the bridge a train was used consisting of two locomotives, each weighing 72 tons, and four cars loaded with rails, weighing 62.8 tons, the total weight of the train being 206.8 tons. As, however, this train was slightly longer than the span, it was necessary to deduct the weight upon one axle of the last car, making the actual weight in the test 199 tons.

The test by dead-weight gave a maximum deflection of 43 mm. and an average deflection of 40.9 mm. under the load. The test for a rolling load at a speed of 25 kilom. an hour gave a maximum deflection of 49 mm., and a mean deflection of 47.5 mm. under the passage of the train.







In both cases the deflection was reduced to zero after the load was removed.

These results being in accordance with the provisions of the contract, the bridge was accepted, and trains commenced to run over it in February of the present year.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

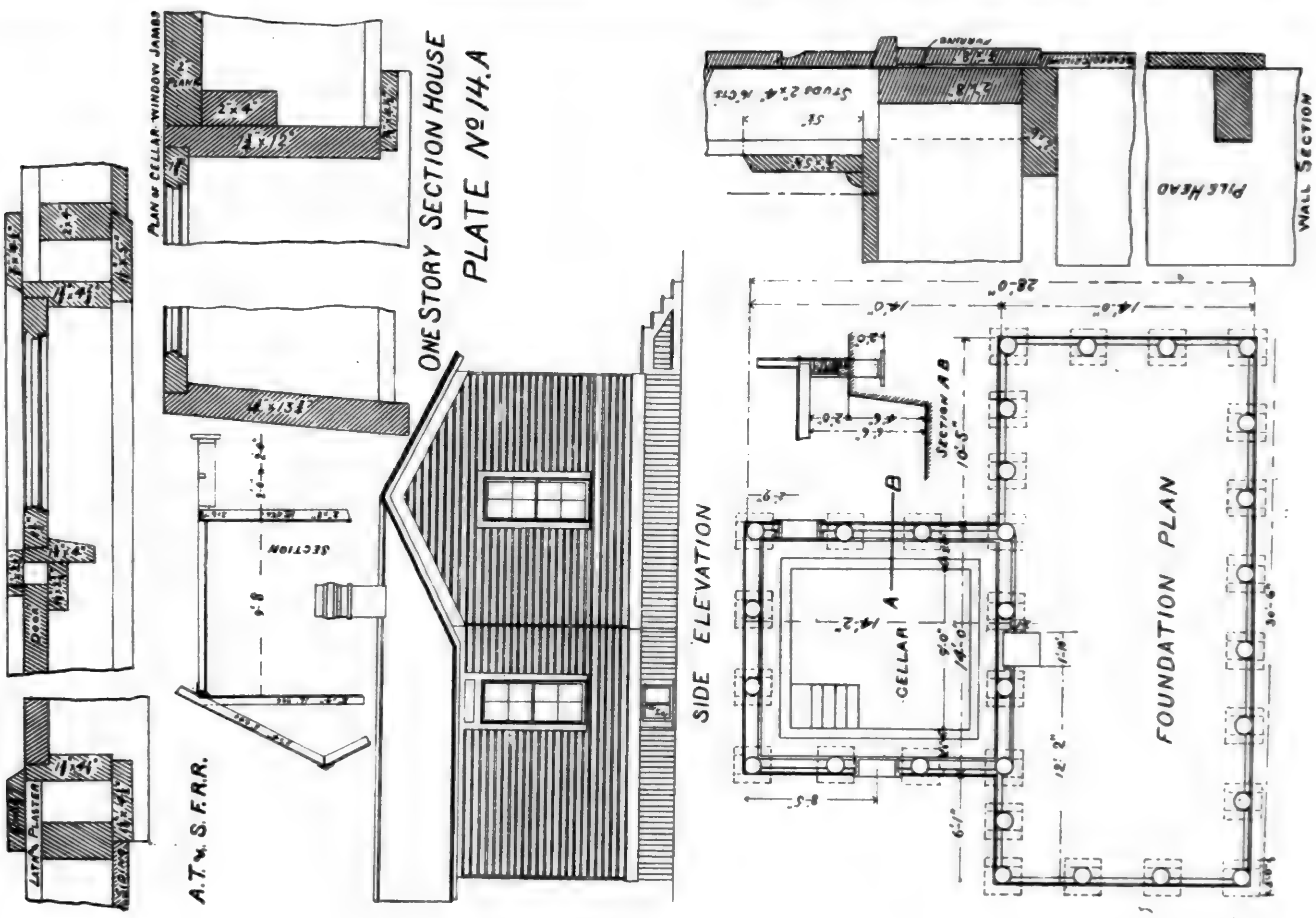
(*Continued from page* 182.)

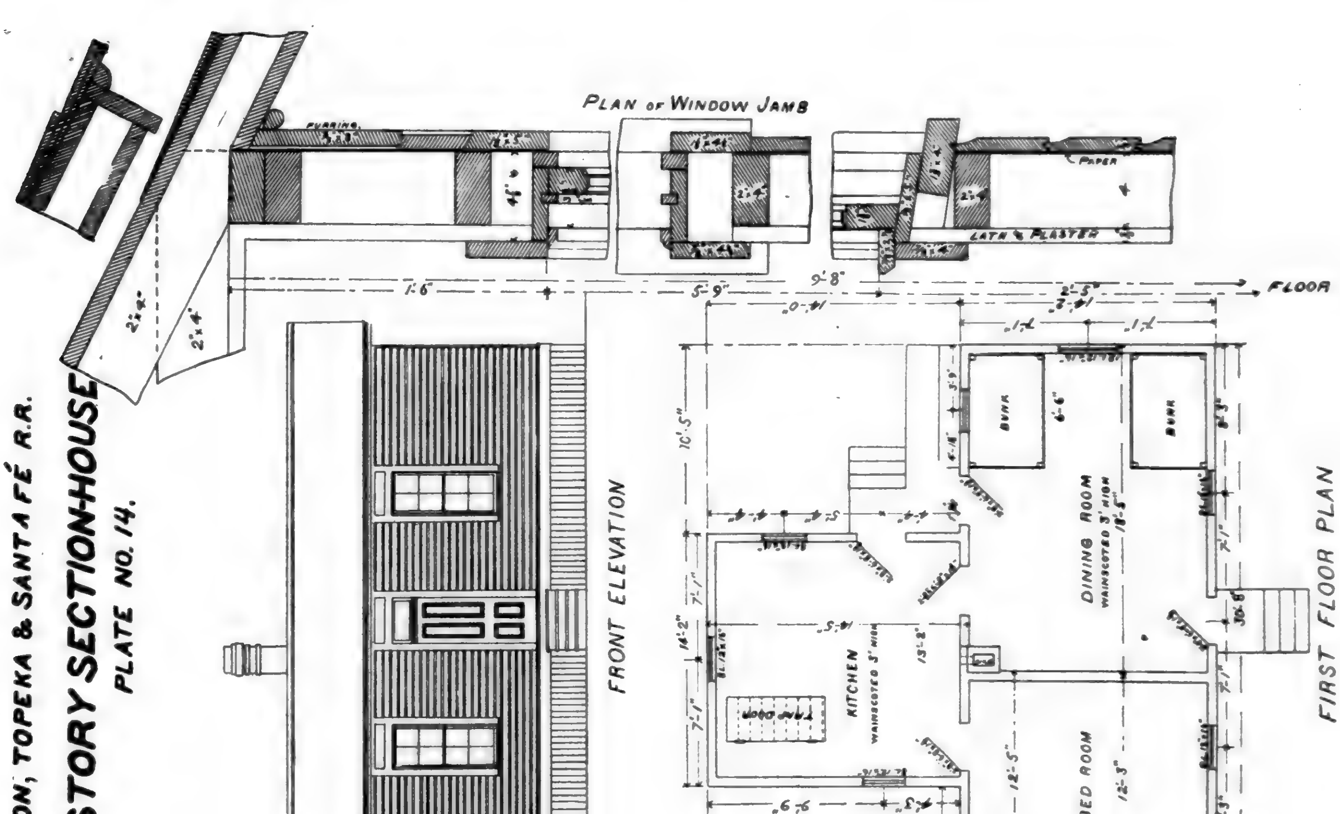
CHAPTER VIII.
SECTION-HOUSES.

Section-houses are intended to furnish dwelling-places for the section-men employed on a railroad. In the railroads running through the newer portion of the country, in the West and the Southwest, these houses are a necessity, as it often happens, especially when the road is first built, that there are no dwelling-houses accessible in the vicinity of the line, and some place of shelter must be provided for the working force.

On all railroads it is a convenience in many respects to have these houses. On many of the older roads, running through thickly settled portions of the country, the trackmen have been allowed to live in the small towns and villages on the road, and in houses not belonging to the company. To some extent this practice continues, but many roads have found it expedient to give it up and to provide dwelling-houses on their property and at their own expense. Reasons for this can readily be seen ; where the men are scattered through a town or village, it is difficult to collect them when they are needed in a hurry, as, for instance, in case of a washout, a wreck, or other emergencies. Other advantages of the system are so plain that it would be hardly worth while to enumerate them.

The section-house should be so built as to supply a neat, comfortable, and sufficient dwelling-house for the trackmen and for their families, with provision made for a certain number of larger houses, where those men who have not families could be boarded. Their location must, of course, be determined by local considerations. In a thickly settled country it will depend to a considerable extent upon the question of where land can be most easily and cheaply obtained ; in a new country, especially where the railroad company owns plenty of land, there will be more liberty of choice. In all cases they should stand upon comparatively high ground, where good drainage can be provided, and where they can be placed without too much crowding.


ONE STORY SECTION HOUSE
PLATE No 14.A
A.T. & S.F.R.R.
SECTION THRO' TRANSOM
PLAN OF CELLAR WINDOW JAMB
SECTION
SIDE ELEVATION
FOUNDATION PLAN
CELLAR
SECTION A.B
PILE HEAD
WALL SECTION
LATH & PLASTER
FURRING


ATCHISON, TOPEKA & SANTA FÉ R.R.
ONE-STORY SECTION-HOUSE
PLATE NO. 14.
PLAN OF WINDOW JAMB
FRONT ELEVATION
FIRST FLOOR PLAN
KITCHEN
WAINSCOTED 3' HIGH
DINING ROOM
WAINSCOTED 3' HIGH
BED ROOM
BUNK
BUNK
FLOOR
PAPER
LATH & PLASTER
FURRING

Where it is possible, especially where the force is of a more permanent character, and many of the men have families, it is well to place them where each house can have some garden ground adjoining it. Other considerations, such as locating the houses near a village where some school facilities are attainable for the children of married men, where supplies can be readily secured, etc., etc., will be taken into account by all railroad officers who have a proper regard for the welfare of their employés.

Plates 14 and 14 *A* show a one-story house of the standard pattern adopted by the Atchison, Topeka & Santa Fé Railroad Cómpany for the smaller class of houses on its line. The illustrations show the general plan and arrangement of this house so completely that very little further description is needed. The full bill of material for this house is given below :

No. 28. Bill of Material for One-Story Section-House.

Plates No. 14 and 14*A*.

Lumber.

29 pile heads, 1 ft. long.
10 pieces, 2 in. × 6 in. × 16 ft. sills.
38 pieces, 2 in. × 8 in. × 14 ft. floor joists.
130 pieces, 2 in. × 4 in. × 10 ft. studding.
38 pieces, 2 in. × 4 in. × 14 ft. ceiling joists.
28 pieces, 2 in. × 4 in. × 12 ft. plates.
24 pieces, 2 in. × 4 in. × 18 ft. cut 9 ft. for rafters.
2 pieces, 2 in. × 6 in. × 14 ft. valley rafters.
6 pieces, 2 in. × 12 in. × 16 ft. footings for posts.
2 pieces, 2 in. × 10 in. × 12 ft. cellar stair horses.
2 pieces, 2 in. × 8 in. × 12 ft. cellar stair treads.
2 pieces, 4 in. × 4 in. × 16 ft. bunk posts.
10 pieces, 2 in. × 8 in. × 16 ft. sills.
10 pieces, 2 in. × 4 in. × 16 ft. nailing for foundation skirting.
2 pieces, 2 in. × 6 in. × 12 ft. platform.
3 pieces, 2 in. × 4 in. × 12 ft. platform joists.
4 pieces, 1 in. × 6 in. × 14 ft. bunks.
2 pieces, 1 in. × 6 in. × 16 ft. bunks.
1 piece, 1 in. × 4 in. × 16 ft. bunks.
240 ft. B. M. 2 in. plank, cellar.
120 ft. lineal 1 in. × 3 in. crossbridging.
650 ft. B. M. 1 in. × 6 in. roof boards.
800 ft. B. M. T. & G. second clear flooring, surfaced.
1,100 ft. B. M. ⅝ in. × 5½ in. drop siding, second clear. (See detail.)
350 ft. B. M. ⅞ T. & G. double beaded second clear, wainscot.
50 ft. B. M. 1¼ T. & G. flooring, second clear, outside steps, etc.
280 ft. B. M. ⅞ T. & G. beaded second clear, skirting.
120 ft. lineal ⅞ in. × 8 in. base, second clear.
136 ft. lineal ⅞ in. × 5 in. facia, second clear.
136 ft. lineal ⅞ in. × 12 in. planking, second clear.
130 ft. lineal ⅞ in. × 8 in. frieze, second clear.
48 ft. lineal ⅞ in. × 5½ in. beveled base, second clear
200 ft. B. M. ⅞ in. finishing lumber, second clear, shelving, bunks, etc.
3,200 laths.
9,000 A. 16-in. shingles.
8 pieces ⅞ in. × 5½ in. × 16 ft. second clear, roof saddles.
2 pieces 1⅛ in. × 12 in. × 12 ft. second clear, outside steps.
136 ft. 1⅜ quarter round, crown mold.
72 ft. lineal ⅞ in. quarter round, exterior corners.
130 ft. lineal 1⅛ in. bead, bed mold.
100 ft. lineal wainscot cap.
148 ft. lineal ⅞ in. quarter round, wainscot base.
1 piece 1⅜ in. × 14 in. × 8 ft. washing shelf.
120 ft. lineal 1⅜ in. × 1⅜ in. water drip.
2 cellar windows, 1⅜ in. sash, 2 lights, 10 in. × 16 in. complete, with frames, to plan.
6 windows complete, with frames and casings, sash 1⅜ in., 8 lights, 12 in. × 16 in.; lower sash balanced, upper sash to have springs tops.
1 window as above, 12 lights, 12 in. × 16in.
1 window and frame complete, 1⅜ in. sash, 4 lights, 12 in. × 16 in. ; frame, 1⅜ in. × 4⅞ in , rabbeted ; sash hung at top, casings as above.
5 doors, 2 ft. 8 in. × 6 ft. 8 in. × 1⅜ in. 4 panels raised, O. G. second quality.
1 frame, with casings complete for outside door, 2 ft. 8 in. × 6 ft. 8 in. × 1⅜ in.; transom 2 lights, 10 in. × 14 in.; all to plan.
2 frames for outside doors, as above, without transoms.
2 frames for inside doors, 2 ft. 8 in. × 6 ft. 8 in. × 1⅜ in., jambs 1⅜ in. × 5¾ in., casings ⅞ in. × 4½ in. beveled.

Hardware.

120 lbs. common building paper.
25 lbs. 3 d. fine nails, lathing.
40 lbs. 3 d. shingle nails.
100 lbs. 20 d. shingle nails.
60 lbs. 10 d. shingle nails.
80 lbs. 8 d. shingle nails.
25 lbs. 10 d. finishing nails.
15 lbs. 8 d. finishing nails.
6 lbs. 6 d. finishing nails.
5 lbs. 4 d. finishing nails.
1 gross 1½ in. wood-screws No. 10.
1 gross 2-in. wood screws No. 12.
5 pairs 3½ in. × 3½ in. cast butts, with screws.
2 pairs 3 in. × 3 in. wrought butts with screws, transom, and window.
2 spring catches.
5 thumb latches.
2 left-hand rural night latches.
1 4-in. Berlin bronze slide bolt.
14 window spring stops No. 734.
28 window spring stops sockets.
14 2-in. axle pulleys.
80 ft. ¼ in. Silver Lake sash cord No. 8.
7 sash locks.
2 doz. wardrobe hooks.
12 sash weights, 6 lbs. each.
2 sash weights, 9 lbs. each.
1 sheet-iron soot drawer, 8 in. × 8 in. × 16 in.
1 terra-cotta pipe thimble, 6 in. diam. × 5 in. long.
2 terra-cotta pipe thimbles, 6 in. diam. × 10 in. long.
30 ft. 16 in. continuous I. C. valley tin.
10 ft. 14 in. continuous I. C. flashing tin.
30 galls. mineral paint.
8 galls. boiled linseed-oil.
½ gall. shellac varnish.
1 gall. turpentine.
45 lbs. mixed paint, light drab color.

Brick and Cement.

500 bricks.
8 bbls. native lime.
6 bush. hair.

Plates 15, 16, 17, and 18 show plans, elevations, and details of a standard section-house of a larger class also adopted by the Atchison, Topeka & Santa Fé Railroad Company. This is a two-story house, containing more rooms, and giving accommodations for a family, or for a larger gang of section men. It is larger, more convenient, and better in many respects than the one-story house, and is but very little more expensive to build.

Below are given the bills of material for this type of house :

No. 29. Bill of Material for Two-Story Section-House.

Plates Nos. 15, 16, 17, and 18.

Lumber.

300 lin. ft. 2 in. × 8 in., sills and foundation plates.
54 pieces 2 in. × 8 in. × 16 ft. floor joists, first and second floor.
4 pieces 2 in. × 8 in. × 14 ft. floor joists, second floor.
13 pieces 2 in. × 8 in. × 12 ft. floor joists, second floor.
190 pieces 2 in. × 4 in. × 18 ft. studding, girts, plates, and sides.
32 pieces 2 in. × 6 in. × 16 ft. ceiling joists.
22 pieces 2 in. × 4 in. × 22 ft. rafters.
2 pieces 2 in. × 6 in. × 14 ft. valley rafters.
950 ft. B. M. ⅞ in. roof sheathing.
400 lin. ft. 1 in. × 3 in. crossbridging.
46 lin. ft. 2 in. × 6 in. ridge piece.
105 lin. ft. ⅞ in. × 6 in. ridge boards.
4 pieces 2 in. × 12 in. × 14 ft. stairs and cellar step strings.
2 pieces 1⅞ in. × 8 in. × 12 ft. cellar steps.
2 pieces 2 in. × 12 in. × 12 ft. step strings.
2 pieces 1⅜ in. × 12 in. × 14 ft. outside step treads.
2 pieces ⅞ in. × 8 in. × 14 ft. outside step risers.
4 pieces 1⅜ in. × 10 in. × 12 ft. inside step treads.
4 pieces ⅞ in. × 10 in. × 12 ft. inside step risers.
4 pieces 1 in. × 6 in. × 14 ft. ribbon.
2 pieces 1 in. × 6 in. × 10 ft. ribbon.
8,250 *A shingles.
1,650 ft. B. M. ⅞ in. s.l.s. common interior sheathing.
7,100 laths.
53 pieces ⅞ in. × 12 in. × 16 ft. C. stock siding exterior, lower story.
60 pieces ⅞ in. × 12 in. × 18 ft. C. stock siding exterior, upper story.
53 pieces ⅞ in. × 3 in. × 16 ft. Ogee battens.
60 pieces ⅞ in. × 3 in. × 18 ft. Ogee battens.
110 lin. ft. ⅞ in. × 8 in. C. stock water-table.
120 lin. ft. 1⅜ in. × 1⅜ in. water drip.
150 lin. ft. ⅞ in. × 4½ in. facia.
120 lin. ft. ⅞ in. × 12 in. frieze.
70 lin. ft. No. 836 P. F. & Co. catg. crown mold.

SECTION HOUSE.
PLATE No 16.

A.T. & S.F. R.R.

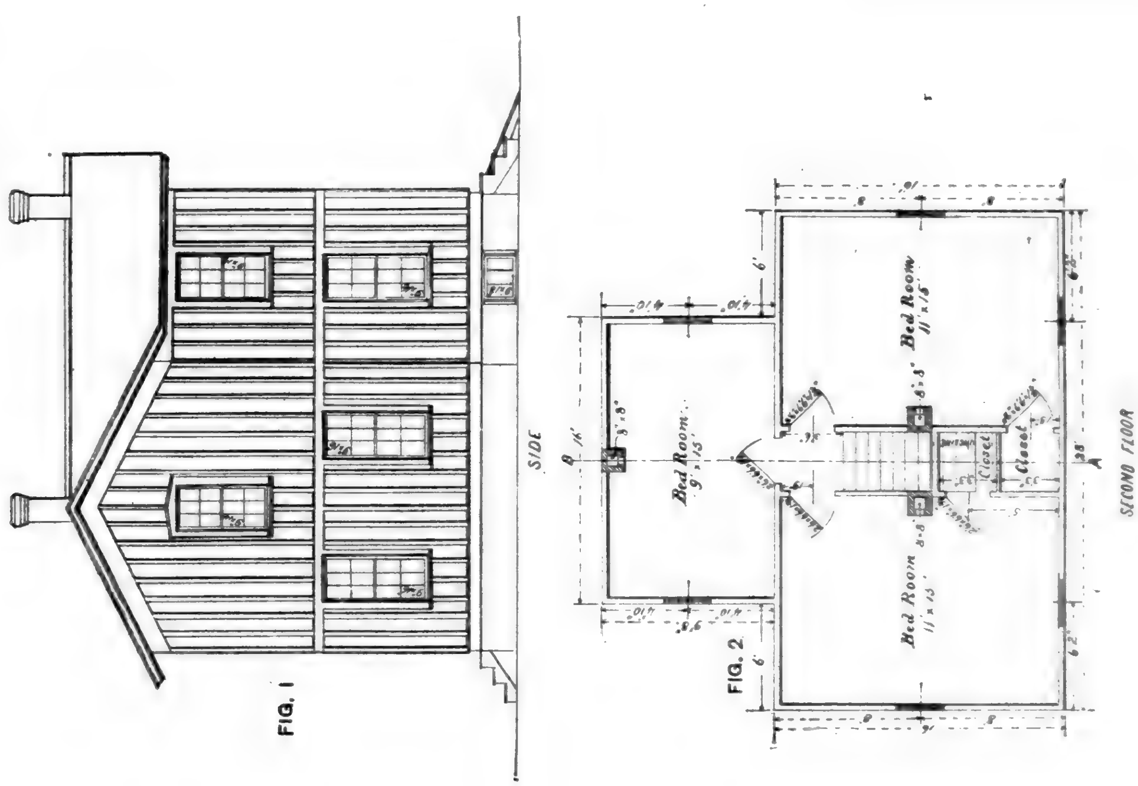


FIG. 1 FIG. 2

SECTION HOUSE.
PLATE No 15.

A.T. & S.F. R.R.

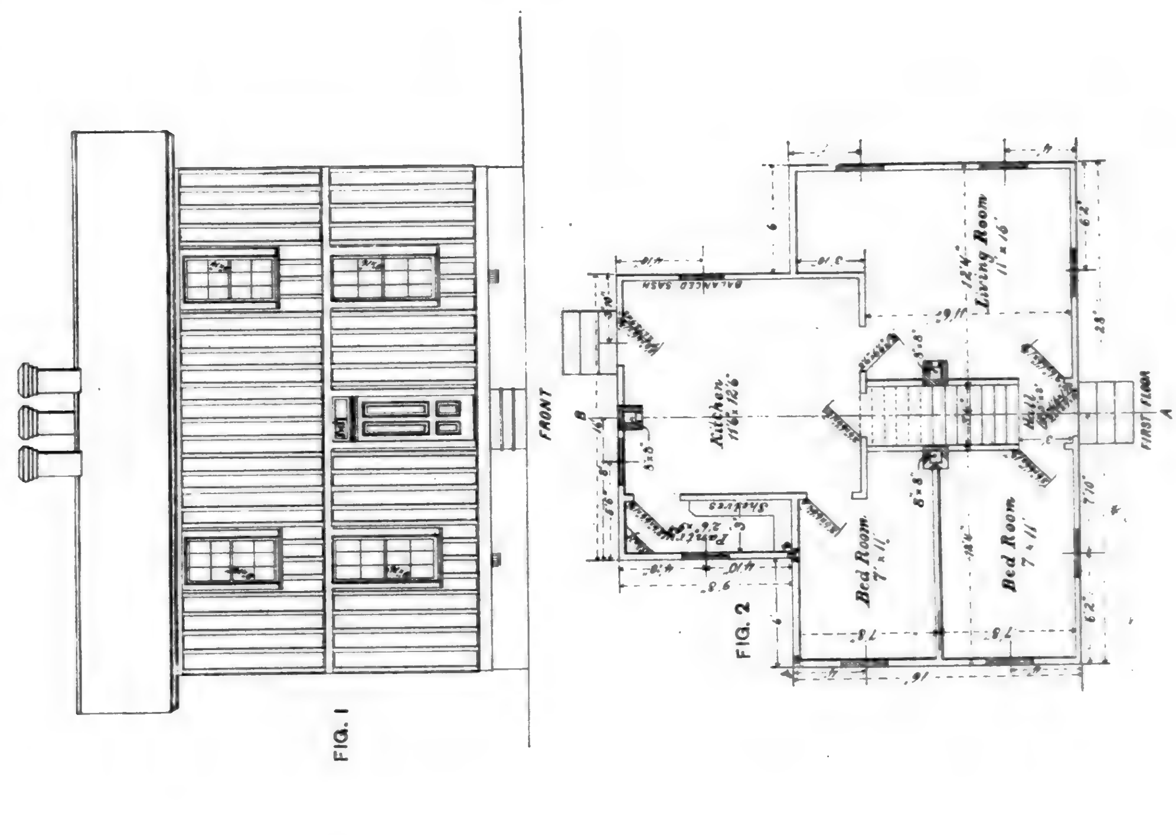


FIG. 1 FIG. 2

80 lin. ft. rake mold for ¼ pitch, to correspond to No. 836 P. F. & Co. catg.
120 lin. ft. No. 907 P. F. & Co. catg. bed mold.
1,290 ft. B. M. ⅞ in. flooring.
360 ft. B. M. ⅞ in. selected fence flooring, plancher and cellar door.
14 pieces corner beads 1¾ in. × 3 in. for plaster corners.
20 pieces ⅞ in. × 5⅝ in. × 16 ft. beveled base.
320 lin. ft. No. 833 P. F. & Co. catg. base mold.
100 lin. ft. 3 in. O. G. battens, wainscot cap.
220 ft. B. M. ⅞ in. narrow beaded W. P. ceiling wainscoting.
3 pieces ⅞ in. × 10 in. × 10 ft. shelves.
6 pieces ⅞ in. × 4 in. × 10 ft. hook strips.

Water Closet and Fencing.

7 pieces 2 in. × 12 in. × 16 ft. sides of cesspool.
7 pieces 2 in. × 12 in. × 10 ft. ends.
4 pieces 2 in. × 4 in. × 7 ft. corners.
2 pieces 2 in. × 4 in. × 8 ft. sills.
1 piece 2 in. × 4 in. × 6 ft. sills.
1 piece 2 in. × 10 in. × 6 ft. floor joists under partition.
48 ft. B. M. 2 in. plank 8 ft. flooring.
15 pieces 2 in. × 4 in. × 8 ft. studding.
2 pieces 2 in. × 4 in × 16 ft. girts.
2 pieces 2 in. × 4 in. × 8 ft. plates.
2 pieces 2 in. × 4 in. × 6 ft. plates.
6 pieces 2 in. × 4 in. × 8 ft. rafters.
12 pieces ⅞ in. × 12 in. × 10 ft. C. stock.
16 pieces ⅞ in. × 12 in. × 9 ft. C. stock.
24 pieces 3 in. O. G. battens, 18 ft.
12 pieces ⅞ in. × 12 in. × 18 ft. D. stock lining.
80 ft. B. M. D. stock 10 ft. roof boards.
600 *A shingles.
2 pieces 3 in. crown mold, 18 ft.
2 ventilators.

Fencing.

49 pieces cedar posts, 5 in. diameter at small end.
130 pieces 1 in. × 6 in. × 16 ft. rough fencing boards.

Walk to Privy.

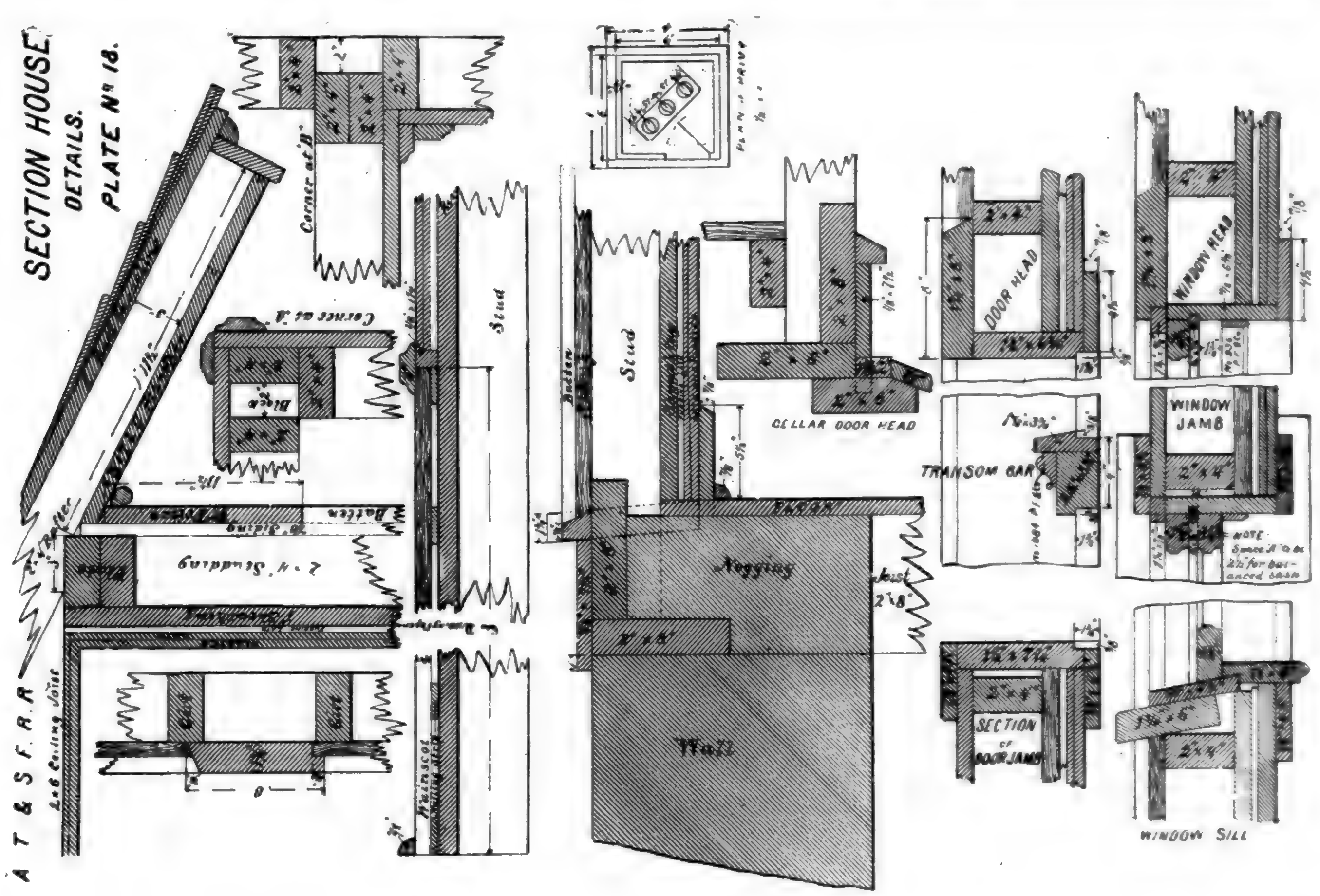
180 ft. B. M. ⅞ in. × 18 ft. fencing.
120 ft. lin. 2 in. × 4 in.

Finished Lumber.

2 outside door frames with transoms.
4 pieces 1¾ in. × 7½ in. × 9 ft. clear W. P. jambs.
1 piece 1¾ in. × 6½ in. × 7 ft. clear W. P. heads.
1 piece 2 in. × 10 in. × 8 ft. clear W. P. sills.
8 pieces ⅞ in. × 4½ in. × 9 ft. clear W. P. inside and outside casing.
1 piece ⅞ in. × 4½ in. × 8 ft. clear W. P. inside head casing.
1 piece 2½ in. × 3½ in. × 8 ft. } transom bar.
1 piece 1¾ in. × 3¾ in. × 8 ft.
8 lin. ft. molding.
2 transoms for above, 1⅜ ft., 2 lights, 9 in. × 13 in.
1 piece 1⅜ in. × 5½ in. × 6 ft. rails.
1 piece 1⅜ in. × 6½ in. × 3 ft. stiles and muntins.
11 inside door frames.
11 pieces 3 ft. ash thresholds.
11 pieces 1⅛ in. × 6 in. × 14 ft. jambs.
3 pieces 1⅛ in. × 6 in. × 12 ft. heads.
22 pieces ⅞ in. × 4½ in. × 14 ft. casing.
5 pieces ⅞ in. × 4½ in. × 14 ft. heads.
1 piece ⅞ in. × 4½ in. × 7 ft. heads.
11 pieces No. 115 H. & W. catg. 14 ft. inside stop.
3 pieces No. 115 H. & W. catg. 12 ft. inside stop.
13 doors, 4 panel raised O. G. 1⅜ × 2 ft. 6 in. × 6 ft. 6 in.
13 pieces 1⅜ in. × 4½ in. × 14 ft. clear W. P. stiles.
4 pieces 1⅜ in. × 4½ in. × 12 ft. clear W. P. top rail.
4 pieces 1⅜ in. × 8 in. × 12 ft. clear W. P. lock rail.
4 pieces 1⅜ in. × 9 in. × 12 ft. clear W. P. bottom rail.
7 pieces 1⅜ in. × 4½ in. × 12 ft. muntins.
7 pieces ⅝ in. × 12 in. × 12 ft. panels.
9 window frames, 12 lights, 9 in. × 16 in. glass.
9 pieces ⅞ in. × 6½ in. × 13 ft. pulley stiles.
3 pieces ⅞ in. × 6½ in. × 10 ft. heads.
9 pieces ⅜ in. × 1½ in. × 12 ft. } blind stops.
3 pieces ⅜ in. × 1½ in. × 10 ft.
9 pieces No. 511 H. & W. catg. 12 ft. } parting strips.
3 pieces No. 511 H. & W. catg. 10 ft.
9 pieces ⅞ in. × 4½ in. × 13 ft. outside casing.
9 pieces ⅞ in. × 4½ in. × 13 ft. inside casing.
3 pieces ⅞ in. × 4½ in. × 12 ft. inside head casing.
3 pieces ⅞ in. × 5 in. × 12 ft. window stool.
3 pieces ⅞ in. × 4½ in. × 12 ft. apron.
12 pieces No. 936 P. F. & Co. catg. 12 ft. window stop.
3 pieces ⅞ in. × 5⅝ in. × 9 ft. subsill.
3 pieces 1¾ in. × 6 in. × 12 ft. sill.
9 pairs 1¾ in. check-rail sash for above frames, 12 lights, 9 in. × 16 in. glass.
3 pieces 1⅜ in. × 10⅛ in. × 9 ft. rails and muntins.
9 pieces 1⅜ in. × 7⅛ in. × 13 ft. stiles and muntins.
6 window frames, 12 lights, 9 in. × 14 in. glass.
6 pieces ⅞ in. × 6½ in. × 11 ft. jambs.
2 pieces ⅞ in. × 6½ in. × 9 ft. heads.
6 pieces ⅜ in. × 1½ in. × 11 ft. } blind stops.
2 pieces ⅜ in. × 1½ in. × 9 ft.
6 pieces No. 511 H. & W. catg. 11 ft. } parting strip.
2 pieces No. 511 H. & W. catg. 9 ft.
6 pieces ⅞ in. × 4½ in. × 11 ft. outside casing.
2 pieces ⅞ in. × 4½ in. × 9 ft. outside head casing.
2 pieces ⅞ in. × 5 in. × 12 ft. window stool.
2 pieces ⅞ in. × 4½ in. × 12 ft. apron.
6 pieces No. 936 P. F. & Co. catg. 12 ft. window stop.
2 pieces No. 936 P. F. & Co. catg. 10 ft. window stop.
2 pieces ⅞ in. × 5⅝ in. × 9 ft. subsill.
2 pieces 1¾ in. × 6 in. × 12 ft. sill.
6 pairs 1⅜ in. check-rail sash for frames, 12 lights, 9 in. × 14 in. glass.
2 pieces 1⅜ in. × 10⅛ in. × 9 ft. rails and muntins.
6 pieces 1⅜ in. × 7⅛ in. × 12 ft. stiles and muntins.
2 cellar window plank frames (rabbeted), 3 lights, 9 in. × 18 in.
1 piece 2 in. × 12 in. × 14 ft. } frames.
1 piece 2 in. × 12 in. × 8 ft.
2 sashes for above, 1⅜ in., 3 lights, 9 in. × 18 in.
1 piece 1⅜ in. × 6 in. × 6 ft. rails.
1 piece 1⅜ in. × 7⅛ in. × 4 ft. stiles and muntins.
110 lin. ft. 1⅜ in. × 7½ in., one side beveled and one side rabbeted band.

Hardware.

6 lights, 9 in. × 18 in. single thick A glass, cellar.
4 lights, 9 in. × 13 in. single thick A glass, transoms.
108 lights, 9 in. × 16 in. single thick A glass, first story windows.
72 lights, 9 in. × 14 in. single thick A glass, second story windows.
8 pieces 2-in. axle pulleys, kitchen windows.
2 gross ⅞-in. round-headed wood screws No. 7.
10 lbs. 8 d. common nails.
30 lbs. 10 d. common nails.
8 lbs. 8 d. finishing nails.
10 lbs. 10 d. finishing nails.
1½ galls. boiled oil.
25 lbs. white lead.
½ gross No. 1 sand-paper.
½ gross No. 2 sand-paper.
48 lbs. putty.
14 gross glazier points.
½ keg 3 d. fine lath nails.
40 lbs. 3 d. shingle nails.
40 lbs. 8 d. common nails.
70 lbs. 10 d. common nails.
100 lbs. 20 d. common nails.
50 lbs. 30 d. common nails.
17 lbs. 8 d. finishing nails.
30 lbs. 10 d. finishing nails.
200 lbs. plain building paper.
4 pairs 3 in. × 3 in. wrought butts, transom and cellar window.
4 pieces spring catches, transom and cellar window.
13 pieces thumb latches, with screws.
13 pairs 3½ in. × 3½ in. loose pin cast butts.
1½ gross 1⅛ in. wood screws No. 10.
2 gross 1 in. wood screws No. 10
1 left hand and 1 right hand rural night latch.
2 Berlin bronzed sash locks.
4 doz. wardrobe hooks.
8 pieces sash weights, 6½ lbs. each.
3 pieces sheet-iron soot drawers, 6 in. × 8 in. × 12½ in.
24 lin. ft. valley flashing tin, 18 in. wide.
32 lin. ft. chimney flashing tin, 14 in. wide.
5 lbs. 8 d. clinch nails.
5 pieces terra-cotta stovepipe thimbles, 6 in. × 4½ in.
2 pieces terra-cotta stovepipe thimbles, 6 in. × 9 in.
52 pieces window spring bolts.
104 pieces window spring bolts, sockets.
48 lin. ft. ¼ in. white Silver Lake sash cord No. 8.
¼ bbl. mineral paint.
9 galls. boiled linseed oil.
50 lbs. white lead.
1 gall. turpentine.
1 gall. shellac varnish.
1 lb. drop black.
1 brass padlock.
1 6-in. hinged hasp and staple.
2 pairs 8-in. T hinges, with screws.


SECTION HOUSE.
DETAILS.
PLATE No 18.
A T & S F R R
Stud
Wall
Nogging
CELLAR DOOR HEAD
DOOR HEAD
WINDOW HEAD
WINDOW JAMB
TRANSOM BAR
SECTION OF DOOR JAMB
WINDOW SILL

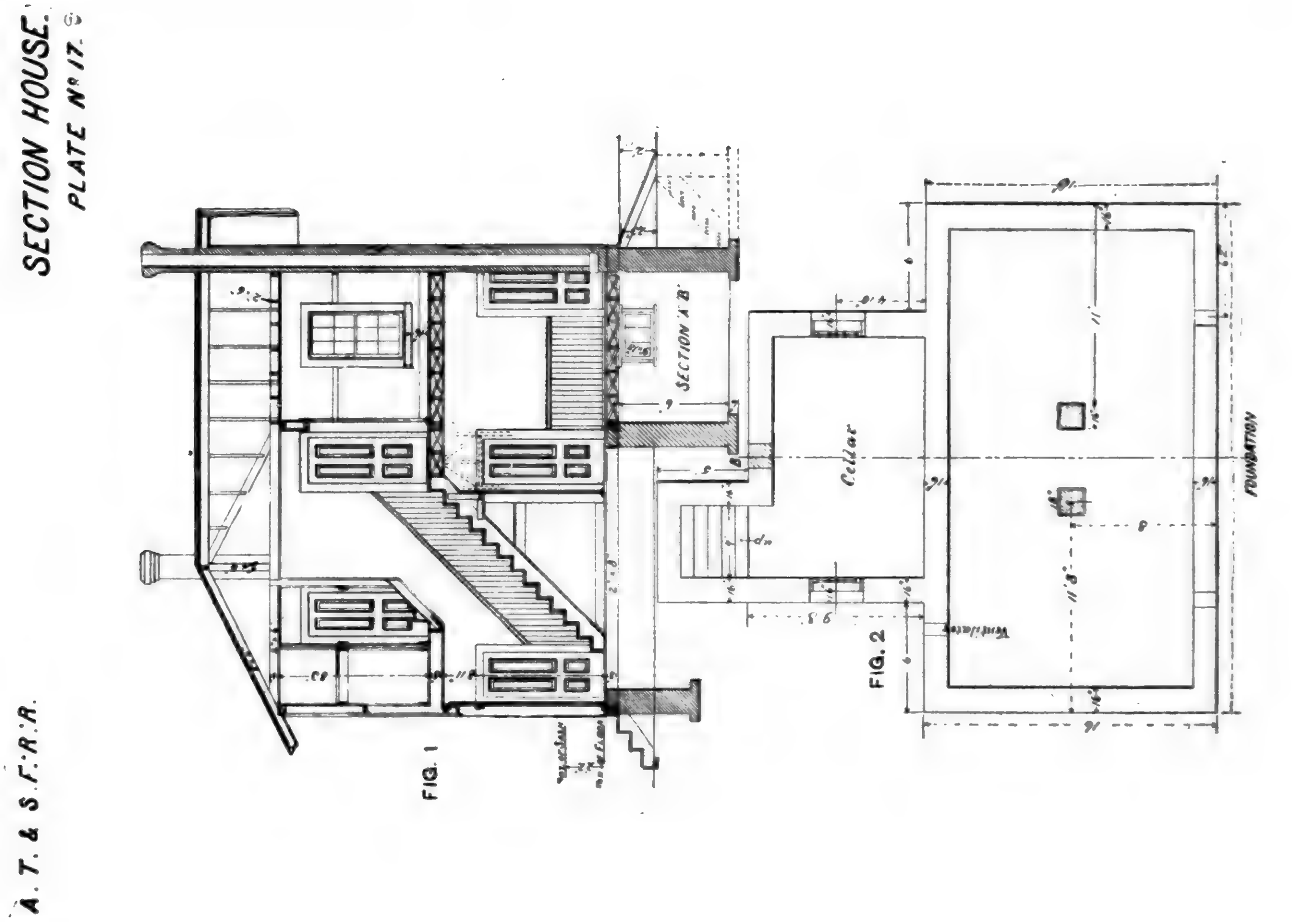

SECTION HOUSE.
PLATE No 17.
A. T. & S. F. R. R.
SECTION A-B
Cellar
FOUNDATION
FIG. 1

FIG. 2

6 lbs. putty.
3 pieces ventilators.
1 cast-iron chimney cap.

Water-Closet and Fencing.

10 lbs. 20 d. common nails.
10 lbs. 10 d. common nails.
6 lbs. 8 d. common nails.
4 lbs. 3 d. shingle nails.
3 lbs. 8 d. clinch nails.
2 pairs 3 in. × 3 in. wrought butt, with screws.
2 thumb latches.
1 night lock.
8 ft. ¼ in. × 1 in. bar-iron for ventilators.

Fence.

25 lbs. 8 d. fencing nails.
2 6-in. strap hinges and screws.
1 St. Louis gate latch.
10 galls. mineral paint.
2½ galls. boiled oil.
1 set Western gate hinges.

Privy Walk.

5 lbs. 8 d. common nails.

Lime, Cement, etc.

15 bbls. white lime.
2 bbls. plaster of Paris.
15 bush. plastering hairs.
2 bbls. common lime.
21 bbls. cement.
2,300 brick.

These plans are, of course, susceptible of such changes as are required to suit local circumstances; they are given as excellent types of small and convenient houses, entirely suitable for the purpose. It is possible that it may sometimes be more convenient to build a single larger structure, divided into tenements; this is not usually desirable, however, and the small single houses will be found better from almost every point of view. The only excuse for the large building will be the high cost of land, as in the neighborhood of a large city, or the impossibility of obtaining rooms.

(TO BE CONTINUED.)

AN ENGLISH COMPOUND SIDE-WHEEL ENGINE.

THE accompanying illustrations from the London *Engineer* show the engines of the side-wheel steamer *Paris*, recently built for the London, Brighton & South Coast Railway Company, and intended to run on that company's line between Newhaven and Dieppe, across the British Channel. The ship and engines were built by the Fairfield Shipbuilding & Engineering Company, Govan, Scotland, from the designs of Mr. William Stroudley, Engineer of the railroad company.

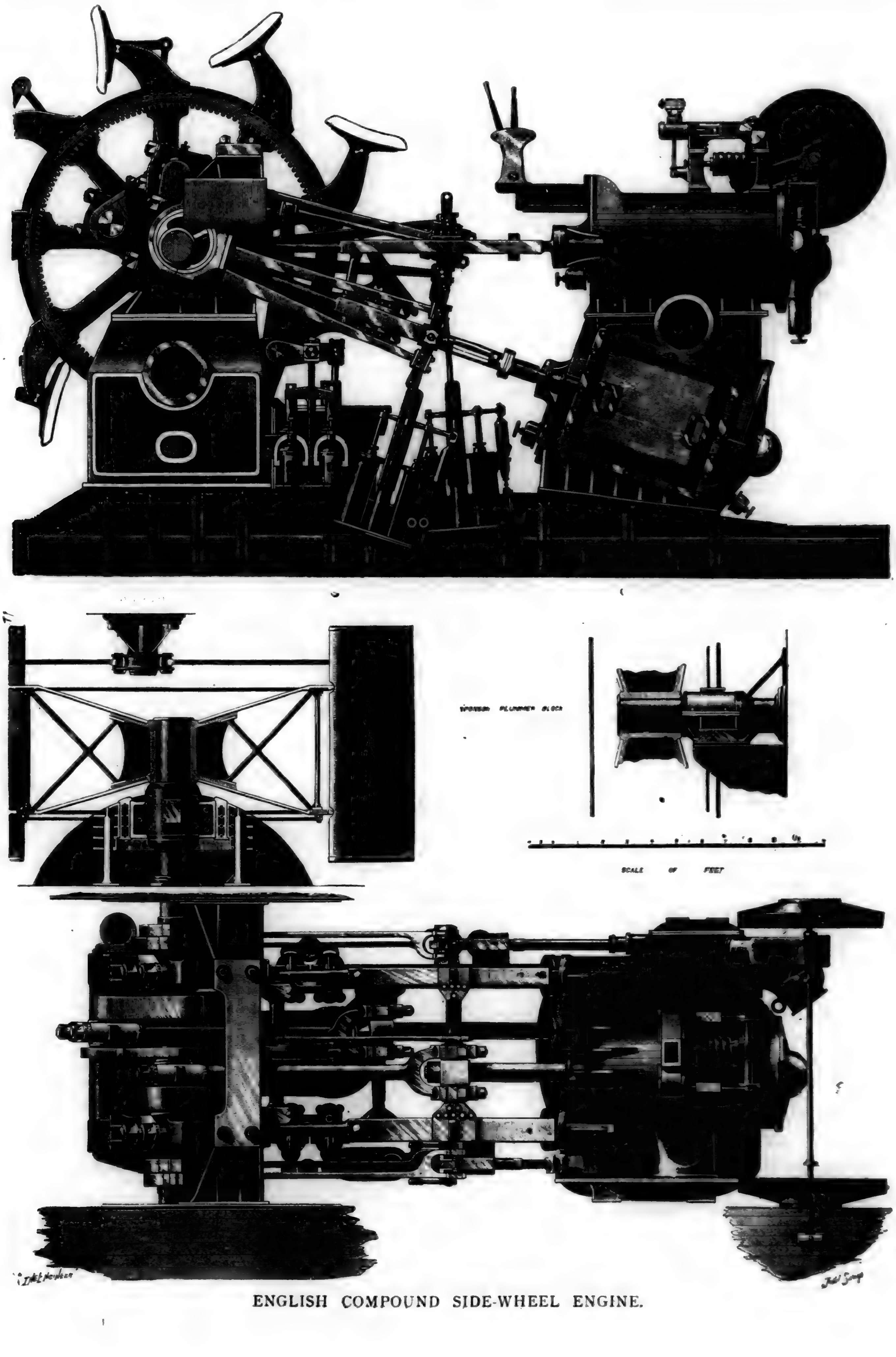
The general dimensions of the vessel are: Length on load water line, 250 ft.; breadth molded, 29 ft.; depth molded, 15 ft.; draft in sea-going order, 8 ft. 2 in. The hull is built of Siemens-Martin steel, and has seven water-tight compartments. On the trial trip, in the River Clyde, a mean speed of 19.057 knots was attained. The ship is intended exclusively for passenger business; it has accommodations for 466 first-class, 108 second-class, and 132 third-class passengers, a total of 706 passengers. The fitting up of the cabins is very handsome, and good accommodations are provided for the officers and crew.

The pilot-house is forward of the foremost smoke-stack, and is fitted with Chadburn's engine-room and steering repeating telegraphs, compass, speaking-tube to engine-room, steering-wheel, and chart table; also one of Stroudley's patent speed indicators, thus enabling the captain to see at a glance the number of revolutions the engines are running per minute.

One of Harrison's steam-steering engines is fixed in the engine-room on top of the high-pressure cylinder, and is worked from the pilot-house for steering the vessel. There is also a powerful hand-steering gear fitted over the rudder, the connections being effected by a clutch which slides on the rudder-head, and so arranged that it takes in one gear before letting go the other. This is fitted with a suitable lever, so that the change can be made in a few seconds in any state of the weather. This vessel is fitted with four large lifeboats, having Sample Ward's disengaging gear, and four Shepherd's collapsable boats, the former lying in skids, and the latter lying inverted alongside them, thus utilizing the same davits.

This vessel is propelled by a pair of compound surface condensing engines of 3,400 indicated H.P., making a maximum of 52 and a minimum of 49 revolutions per minute. The cylinders are placed abaft the shafts, which are carried on the condenser, the high-pressure cylinder being on top of the low-pressure cylinder, which is diagonal. These cylinders are placed one slightly to port, and the other to starboard of the center line of the vessel, so as to bring them into line with their respective crank-pins, which are connected together with a drag link. The high and low-pressure cylinders are respectively 46 in. and 83 in. in diameter, the stroke in both cases being 6 ft. They are steam jacketed, and provided with manholes in the covers for access to interior. The pistons are of cast steel, of dish form, adopted by Mr. Stroudley with great success in his locomotives and steam vessels. Each junk-ring has a shoe cast on the lower part of its circumference, so as to increase its bearing area on the cylinder. This arrangement was designed by Mr. Stroudley, to dispense with tail-rods passing through the cylinder covers, and has worked most satisfactorily. The high-pressure cylinder is fitted with a single-ported slide valve, while the valve of the low-pressure cylinder is double-ported. The valves are driven by link motion, the expansion links being of the double-bar type. The valve spindles, eccentric rod ends, and lifting links, are fitted with adjustable bearings. Each valve motion is reversed separately by Brown's patent steam and hydraulic reversing engine arranged with one oil and two steam cylinders, working direct on to the expansion links. By this arrangement the engineer can alter the expansion of each engine as required. The crank-shafts, crank-cheeks and pins, the latter forged in one piece, are of Siemens-Martin steel, Messrs. Vickers, Sons & Company's best make; the whole of the other forgings for the engines and paddle-wheels are of Siemens-Martin steel—Parkhead Forge Company's make—of a tensile strength of 33 tons per square inch, and capable of being folded up quite close while cold. The shafts are 16 in. diameter, and the crank-cheeks and pins are forged solid. The crossheads have adjustable guide faces of cast steel lined with white metal; the condenser is of cast iron, with plummer blocks cast on for carrying the air-pump shaft, and cast-steel plummer blocks attached for carrying the main shafts. These have long brackets bolted to the coaming of the engine-room, and forming a very strong cross-stay to the vessel, at the same time securing the rigidity of the main bearings. The condenser is fitted with brass tubes tinned on the outside, ¾ in. external diameter, having 3,681 square feet of cooling surface. The condensing water is supplied by one of Messrs. W. H. Allen's centrifugal pumping-engines. This pump forces the water through the condenser, the tubes of which are in two groups, so that the water makes two runs from end to end. The air-pump is of gun-metal, single-acting, 37 in. diameter, with 30-in. stroke, fitted with Thompson's patent metallic valve, and is driven by a bell-crank lever connected by a rod to the crosshead of the high pressure engine. From the same pump shaft are also driven two feed and two bilge-pumps, having gun-metal plungers 8 in. diameter and 18-in. stroke; one of the latter is arranged to work as a sanitary pump, to circulate water through the water-closets and urinals when the engines are at work. The various levers for handling these engines are brought together on a level with the main deck, immediately in front of the high-pressure cylinder, enabling the engineer to have a good view of the engine.

The paddle-wheels are on the feathering principle, overhung and supported by cast-steel slings under the plummer blocks and wing brackets on the ship's side. They have inside rims, and are 17 ft. diameter to the axes of the floats. There are nine floats in each wheel curved on the driving face, with flanges at the ends as designed by Mr. Stroudley for the steamships *Brighton* and *Victoria*, built by Messrs. John Elder & Company, for the Brighton Com-



ENGLISH COMPOUND SIDE-WHEEL ENGINE.

pany in the year 1878. The floats are of Siemens-Martin hard rolled steel, 10 ft. by 3 ft. 7½ in.; six of these in each wheel are ⅞ in. thick, two 1¼ in., one 1⅝ in. thick, to properly balance the engine and prevent fore-and-aft motion in the ship. The paddle-wheel centers are of cast steel, also the feathering studs and feathering-rod bosses. The recesses for the paddle-arm are planed parallel as to their length, but are slightly tapered as to their depth, so that the arms are drawn in by the bolts to a metallic fit. All the wearing surfaces are of gun-metal working on lignum vitæ. All this work is put together with turned and fitted bolts, having cup heads and one nut to each bolt, the point of the bolt being lightly riveted over. All bolt holes are opened out with a cylinder drill, and the bolts driven in with a 7-lb. hammer.

Steam is supplied to the engine at a working pressure of 110 lbs. from four multitubular boilers, two placed at each end of the engine-room, with the furnace fronts facing the engines. They are 13 ft. diameter and 9 ft. 6 in. long, each being fitted with three Fox's corrugated furnaces 3 ft. 5 in. mean diameter by $\frac{7}{16}$ in. thick. The shells are $1\frac{1}{16}$ in. thick, and are each composed of two plates, one long and one short, the long plate extending from the water-level on the opposite side, the shorter going over the top of the boiler. The joints of these have double-butt straps ⅞ in. thick. Each boiler is fitted with 318 patent iron tubes—Allan, of Coatbridge, make—2⅜ in. diameter outside, 6 ft. 7½ in. long, No. 9 B. W. G. thick, and has a total heating surface of 1,842 square feet, and a total fire grate area of 71.75 square feet.

The engine-room and stoke-holds are so arranged that the doors, windows, etc., can be made air-tight, and the air forced into the same by a pair of 6 ft. diameter fans driven by one of W. H. Allen & Company's 7 in. by 7 in. single cylinder engines. This engine is attached to the high-pressure steam-chest to prevent noise when working, and the exhaust steam is delivered into the receiver of the main engine. Mr. Stroudley has adopted this arrangement with the various engines used for electric lighting, circulating pumps, fans, etc., for some years, the back pressure entirely preventing the usual disagreeable knocking caused by these small engines, particularly when the exhaust is turned directly into the condenser. The average H.P. used in making the ordinary runs does not exceed 3,000. The maximum speed at which this vessel has worked on the passage between Newhaven and Dieppe gives an average from pierhead to pierhead of 19¼ knots per hour, the time being 3 hours 20 minutes; the average time for a month was 3 hours 32 minutes. This boat was designed for the purpose of making the passage from wharf to wharf in four hours, and as the time required to get from the wharf to pierhead and pierhead to wharf on the other side only amounts to about 12 minutes, it has a considerable margin of power to keep the official time and meet the emergencies of bad weather. A careful analysis of the coal burned shows that this engine gives off 1 H.P. on something less than 2 lbs. of the average duty. This, of course, includes steam used in the fan-engine, steering-engine, heating all cabins, etc., steam-winch engine, and engine used for circulating condenser water. Were this engine only credited with the coal actually burned, the consumption per H.P. would be about 1¾ lbs. only.

A sister ship, the *Rouen*, has also been recently completed and put on the same line.

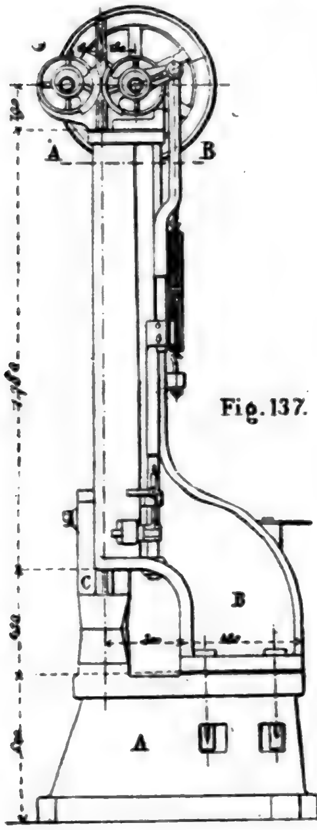


Fig. 137.

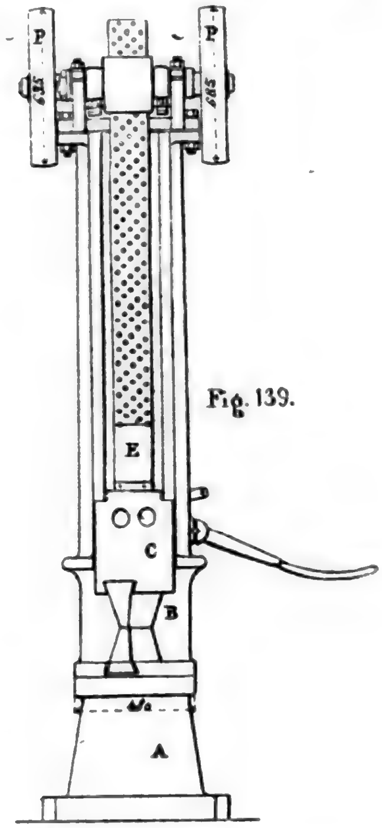


Fig. 139.

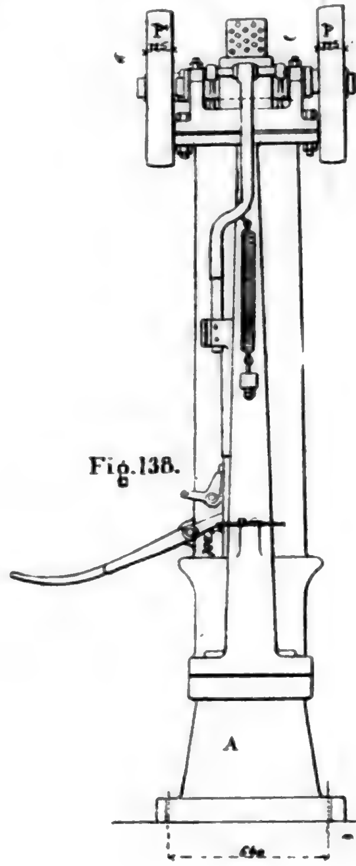


Fig. 138.

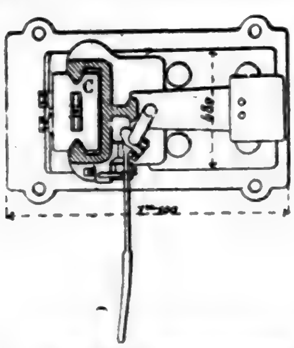


Fig. 141.

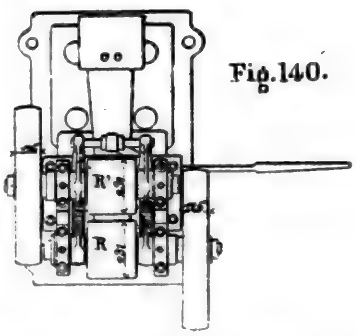


Fig. 140.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 167.)

CHAPTER XLIII.

THE HASSE DROP HAMMER.

This hammer, represented in figs. 137–42, differs from those previously described, in that the rod by which the hammer is worked is a wooden plank, upon which friction rollers act for the purpose of raising the hammer to a height which may be varied at will.

Fig. 137 is a side view; fig. 138, a rear view; fig. 139, a front view; fig. 140, a plan, and fig. 141 a section on the line *A B* in fig. 137. The hammer shown in the engraving is of 150 kilog. weight.

It is composed of an anvil-block *A*, on which is fixed the frame *B*; this frame carries slides between which moves the hammer *C*.

The rod or board *E* of the hammer is formed by three thicknesses of wood, as shown in section in fig. 142, the

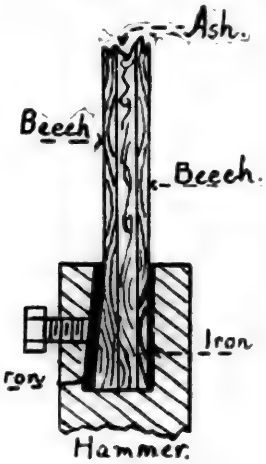


Fig. 142.

center being of ash and the two outside plates of beech; the construction of this rod requires particular care, and the wood used should be very dry. The three thicknesses are fitted together and then pierced with holes into which are forced wooden pins, previously coated with strong glue.

To prevent the rod from rising too high, it is made slightly thicker near the hammer. It is connected with the hammer by means of a mortise in the head, and is held fast by set-screws acting on an iron plate, as shown in fig. 142.

At the top of the frame there is fixed a plate carrying four pillow-blocks, intended to receive the two driving shafts and the friction rollers *R R'*. These rollers are of cast iron, and are turned exactly of the same diameter; they receive a continuous rotary movement in opposite direction, by means of two pulleys *P P'* worked by crossed belts. These pulleys are run from 100 to 120 turns per minute. The friction necessary to raise the plank by the rollers is produced by drawing the latter together through the following arrangement: The shafts of the rollers turn in cast-iron eccentric boxes, which can themselves turn in the pillow-blocks; these boxes carry toothed sectors which gear together in pairs. By means of the rod *E* the hammerman moves two of these boxes, which transmit the motion to the other two through the toothed sectors, and thus, through this eccentric movement, the rollers *R R'* are made to approach each other, or to separate. The rod *E* is worked by the hand-lever *L*.

The spring *S* serves to regulate the contact of the rollers, so that the hammer may be kept slightly raised when the rollers are in motion, and without touching the lever *L*, in such a way that the work required to raise the hammer is very slight when the tension of the spring is sufficient. The required tension is obtained by tightening the screw on the lower part of the spring.

The stroke of the hammer is, then, variable at will. It is especially useful for stamping, rather than for forging or drawing out, on account of the comparative slowness of its action.

CHAPTER XLIV.

THE SCHOENBERG DROP HAMMER.

The drop hammer of the Schoenberg type differs from other similar hammers only in the method of raising the

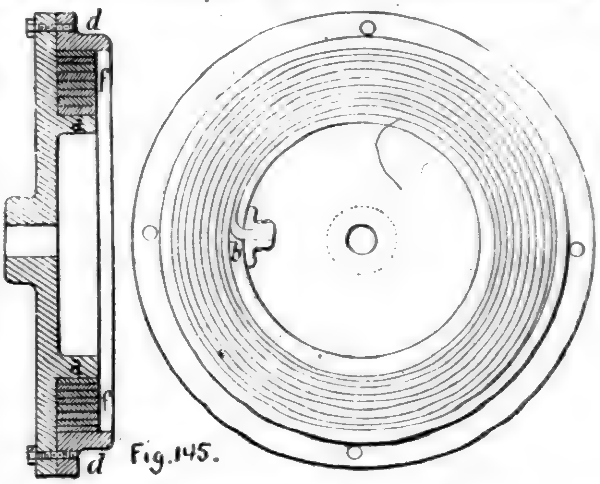


Fig. 145.

rod, and by the construction of the rollers, which are made as described below. After having cast upon the arms of a pulley or face-plate a lug *d*, fig. 145, of the same width as that of the hammer-rod or belt, a slot *b* is made of the same section as that of the belt, and, after having fixed the end of this belt in the slot by means of two bolts, the pulley or face-plate is put upon a shaft and at the same time that it begins to revolve the belt is pressed tightly against it in such a way that it forms an annular block of leather, which is left to dry equally without pressure. This block is then taken off to be turned up to a fixed diameter, and is bolted in place by means of a ring *d d*. All that remains then to be done is to finish it up properly on the surface *f f*, to obtain an annular leather plate, which is in contact at every point, and which cannot possibly get out of shape, no matter what may be the ultimate pressure exercised upon it.

As we have already seen, the engagement of the roller is produced by the friction of a carefully polished iron ring

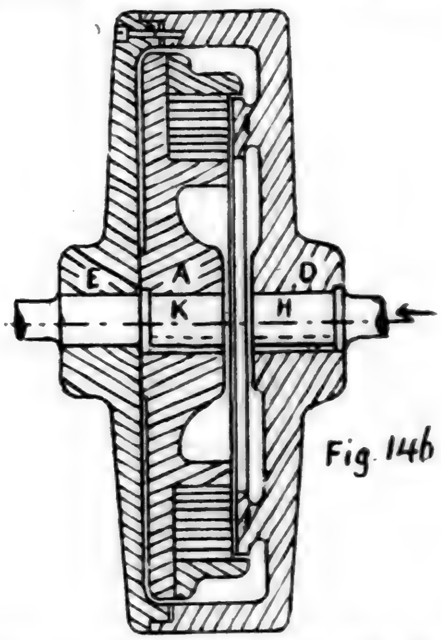


Fig. 146

on the annular surface of this leather block, as shown in fig. 146. By examining this drawing it will be seen that the plate *A* is fastened to the shaft *K*, which moves the whole mass, or is moved by it; the plate *D*, fixed upon the

shaft *H*, movable in a horizontal direction, is of cast iron, with the friction plate *I I* of which we have already spoken. In order that the surfaces may not lose their contact at any moment, a third plate, *E*, fastened to the plate *D* by a series of screws, encloses the plate *A*, and has its bearing on the

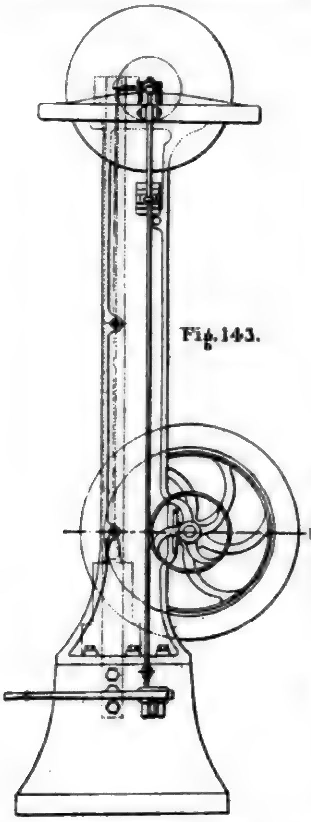


Fig. 143.

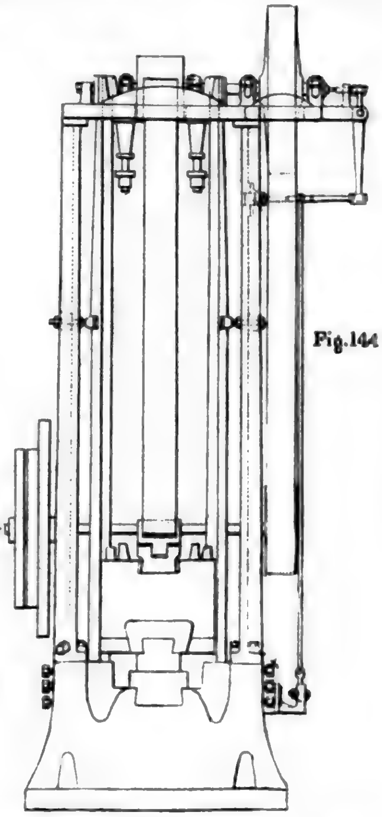


Fig. 144.

driving shaft *K*, but is not fastened to that shaft, turning loosely upon it.

To set the hammer in motion by hand only requires the movement of levers sufficient to produce the very slight motion needed to bring together the two friction plates, which are less than a millimeter apart.

The general construction of the hammer is shown in figs. 143 and 144, fig. 143 being a side view and fig. 144 a front view. The hammer shown here is one of 350 kilogs., made by M. Delinotte, at Paris, who holds the French patent. They are made of weights varying from 350 to 1,800 kilogs. Another class of hammers is on the same principle, but with a single frame, instead of the double frame shown in the engraving.

In all these hammers it will be seen that the slides upon which the hammer works are independent of the cast-iron frames; in this way the wear upon the slides can be readily taken up. For this purpose there are placed at top and bottom, between the slides and the frame, several thin plates of sheet iron, the number of which can be increased or diminished as required.

These hammers can be run in two ways: 1. By hand, being worked in this case by the helper; 2. By the hammerman himself through a foot-lever. An inspection of the drawings will show that only a very slight movement is required to throw the friction pulley in place or to withdraw it, as noted above.

Where the hammerman himself works this tool with a foot-lever the arrangement is as follows:

1. The hammer having approached the top of the stroke, the workman pressing on the pedal withdraws the lock, and the hammer falls.

2. At the moment when the hammer strikes the forging, the workman takes his foot from the pedal, which rises and causes the rod *E* to descend, thus renewing the friction, and the hammer is raised.

3. The hammer arrives at the head of its stroke at the same time that it acts upon a bolt placed at this point, pushes a dog acting on the rod *T*, which, then freed from friction, leaves the hammer ready to fall when the workman presses on the pedal. As will be seen, the mechanism is very simple. Moreover, the automatic action of the hammer can be varied for different heights by changing the bolts and the dog which throws the friction rollers into action. When the height of the fall is once regulated in this way, it remains the same until again changed.

This type of hammer is especially convenient for die work and for stamping small pieces, and is largely used in the State factories of small arms at St. Etienne, Tulle, and Chatellerault, and also in many private workshops.

CHAPTER XLV.

THE BARBIER DROP HAMMER.

The principal inconvenience of drop hammers is, that hitherto they have been principally worked by some system of pulleys with springs, and these springs act constantly to a greater or less degree on the bolt or rod in the descent of the hammer. From this there results a heating of the rod or plank and a complete absence of adhesion, which, with heavy hammers, makes it impossible to work them continuously. Moreover, this heating of the belt or plank and the continual friction produce rapid wear.

The Barbier drop hammer, shown in figs. 147, 148, and 149, differs from other hammers of this class by a use of an apparatus called an isolator, the object of which is to draw the belt back from the friction pulley. Before describing this we should say that in the Barbier hammer the driving pulley or friction pulley is formed by two pulleys with dished sides, carried on the same shaft, but having between them a clear space of 25 to 35 mm., in which is placed the isolator. This apparatus is composed of three

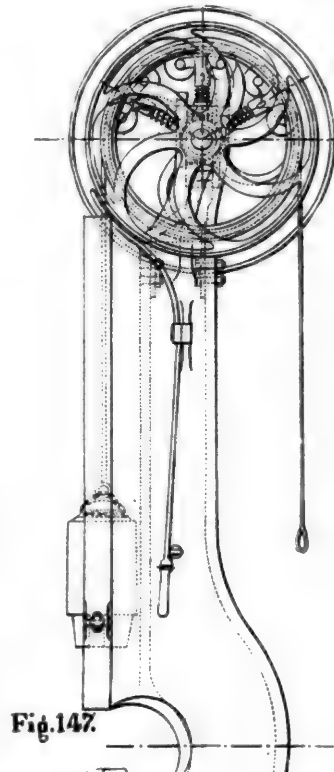


Fig. 147.

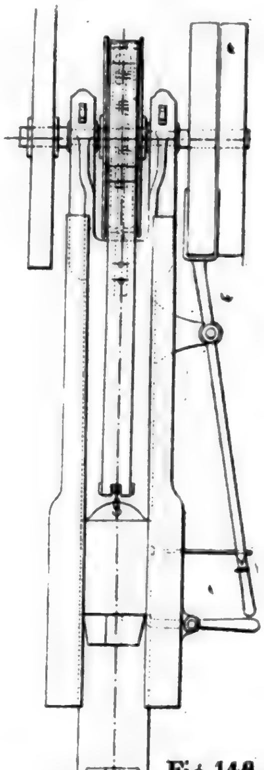


Fig. 148.

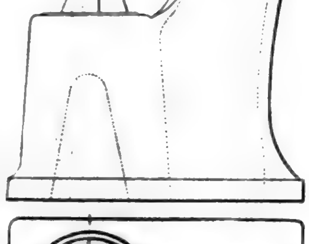


Fig. 149.

groups, each of two small rollers; each of these systems moves on a rod, where it is held in place by a spring.

The isolator is regulated in such a way that when it is at rest these rollers are higher than the pulley, and raise the belt clear of it. In putting the belt at work the rollers

are lowered by the pressure exercised by the workman, the belt adheres to the pulley and raises the hammer. But as soon as the pressure is removed the springs throw up the rollers and free the belt, which then moves over these rollers, instead of pressing upon the springs, as in the other hammers. In this way the continual friction and the rapid wear of the belt or rod are avoided, and moreover the hammer strikes with its full force, because it has no resistance to overcome.

The diameter, the face and the speed of the friction pulley being determined and calculated according to the

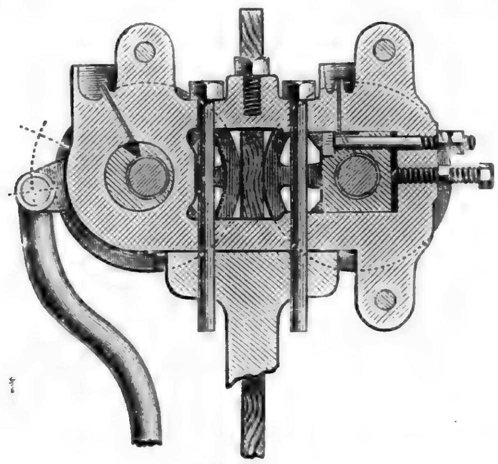


Fig. 151.

weight of the hammer, the work to be done by the hammerman consists simply in exercising suffici nt force to deflect the spring carrying the rollers, and this work can be reduced to a very small quantity.

Many applications of this system have been made upon existing hammers and in stamping machinery; a notable one is in the die-hammers or stamps used in the manufacture of zinc ornaments, where the striking mass frequently weighs as much as 450 kilogrammes.

On the other hand, die-work and stamping done by hammers provided with this arrangement give excellent results, as, there being no friction at the moment of the stroke, the hammer gives its full blow and without reaction. This arrangement is found at work in many shops of greater or less importance, and also in a number of the State workshops and arsenals.

CHAPTER XLVI.

THE MERRILL DROP HAMMER.

This hammer, which is manufactured by Merrill Brothers, Brooklyn, N. Y., is shown in perspective in fig. 150. Fig. 151 is a section of the head, showing the method of working the friction rollers, which especially distinguishes this hammer from others of the same class.

The Merrill hammer has the general features of all drop hammers—that is, the anvil and upright frames carrying the slides in which the hammer works, the heavy hammerhead, and the board upon which the friction rollers act to raise the hammer. The rollers are carried on two separate shafts running in pillow-blocks carried at the top of the frame, and each shaft has its pulley driven by a separate belt; all gearing is thus dispensed with. The rear shaft—that is, the one at the back of the board—runs in boxes of the ordinary pattern, which can, however, be set up by means of set-screws, to take up wear in the board or in the rollers. The shaft on which the front roller is keyed runs in eccentric sleeves, placed in stationary boxes, and the movement of these sleeves brings the rollers in contact with the board, or, by releasing them, leaves the hammer free to drop. The motion required of these eccentric sleeves is only a small portion of a circle; they carry arms to which is attached the drop-rod. When this rod falls it revolves the sleeve and brings the rollers into contact with the board. When the rod is raised the rollers are separated, and the motion is so arranged that they are then well apart, and do not touch the board, leaving the hammer perfectly free to fall without friction, and with its full weight. The drop-rod is made heavy, so that its weight will always be sufficient to bring the rollers into place.

The rollers can be moved at the pleasure of the operator. By pressing the treadle down the latch on the right side, on which the hammer rests when not at work, is thrown out, and at the same time the drop-rod is raised, opening the rollers and allowing the hammer to fall. As soon as

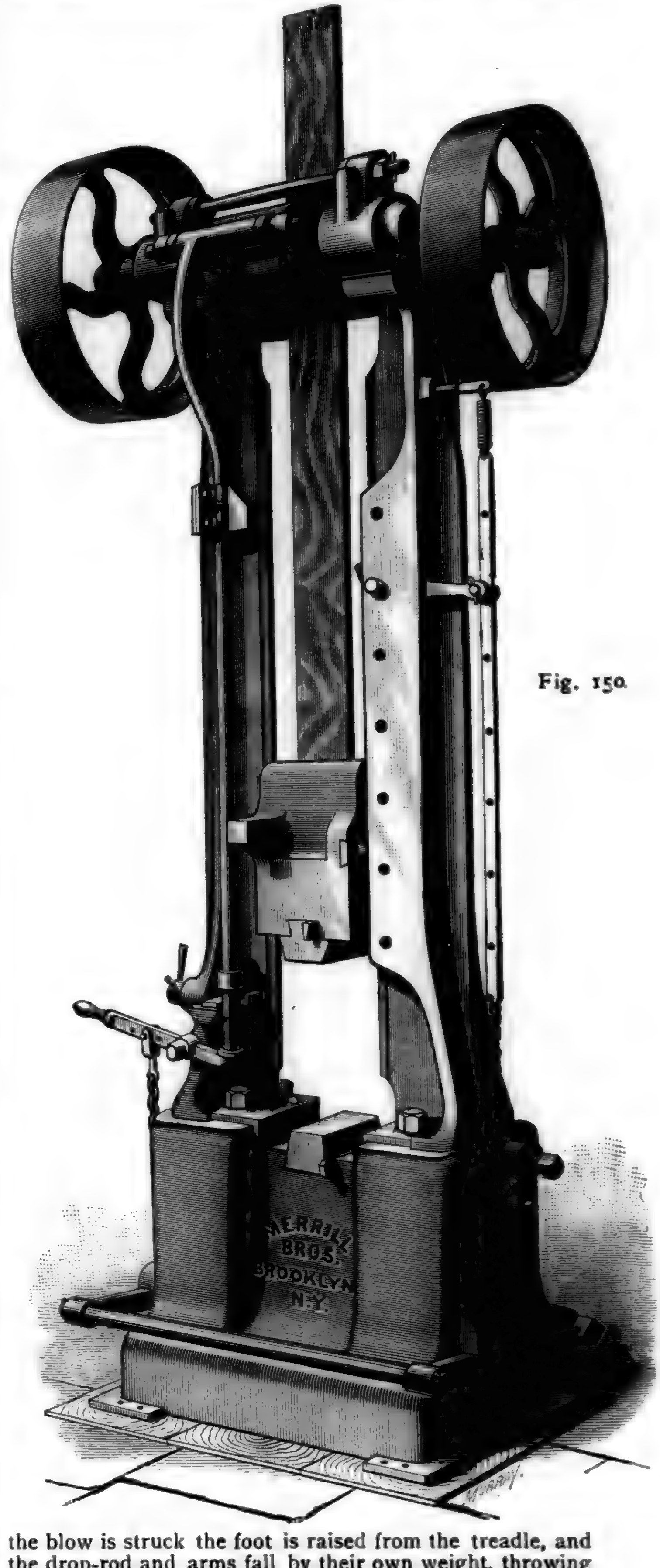


Fig. 150.

the blow is struck the foot is raised from the treadle, and the drop-rod and arms fall by their own weight, throwing the rollers together, and the hammer rises immediately. The latch, which is shown in fig. 150 on the right-hand side, serves to hold the hammer up safely and out of the

way when the dies are being adjusted, or when the hammer is not in use. It is held in place by a pin passing through the frame, and can be adjusted at a number of different heights.

The hammer will thus follow the motion of the foot down and up, and can be regulated by the pedal at the will of the operator, striking short and light blows by frequent movements of the foot, or rising to a greater height and striking heavier blows, as required. If the foot is taken off altogether the hammer rises to the highest point to which it may be adjusted, and there rests upon the latch until it is tripped by the pedal.

While the hammer is falling, if the workman does not wish it to strike, he simply removes his foot from the treadle, when the drop-rod will fall, closing the rollers, and the hammer will rise without striking. The action of this tool, it will be seen, is thus very easily adjusted at will, and can be regulated for almost any kind of work, making it an exceedingly useful tool for die-work, stamping and drop forgings of all kinds, from the largest to the smallest pieces.

Its construction, as will be seen from the engraving, is very simple, as it consists only of the frames, which are bolted to the anvil block, and which are connected above by tie-rods passing through the two top castings, which carry the boxes in which the friction rollers revolve. It has also the merit that in case of breakage nearly all the repairs can be made in a blacksmith shop without requiring finished or fitted work. The hammer-board is usually made of white oak, and it is found in practice to last from three to six months, according to the work required of the hammer. A hand-lever is provided for working the drop-rod, which can be used when desired. An automatic attachment is also provided which can be placed on the hammer if required, but it is found that an experienced hammerman usually prefers to dispense with this.

These hammers are made in different sizes varying from 300 lbs. to 1,800 lbs. weight of hammer, and a considerable number of them are now in use in different shops. They are very excellent tools of their class, both for simplicity of construction, ease of working, and readiness of adjustment.

CHAPTER XLVII.

GENERAL REMARKS ON DROP HAMMERS.

Drop hammers have this great advantage, that they are worked from belts and can be used in any place where power can be transmitted, and can consequently be set at work at once, without having to provide steam, as in a double-acting steam hammer.

As a general rule the drop hammer should not go beyond 300 kilogs. (660 lbs.) weight of hammer, and it is safer beyond that weight to use the double-acting steam hammer.

There is one exception to this rule, and that is with hammers used for stamping or drop forgings; with these we may go as high as from 600 to 1,500 kilogs. (1,300 to 3,300 lbs.) weight of hammer and a stroke as long as 3 meters (9.84 ft.).

With these limitations the drop hammer is an exceedingly useful tool, and finds an appropriate place in a large number of work-shops. It will be found available in many small shops where the work required would hardly warrant the erection of the boilers and other accessories needed for a steam hammer.

(TO BE CONTINUED.)

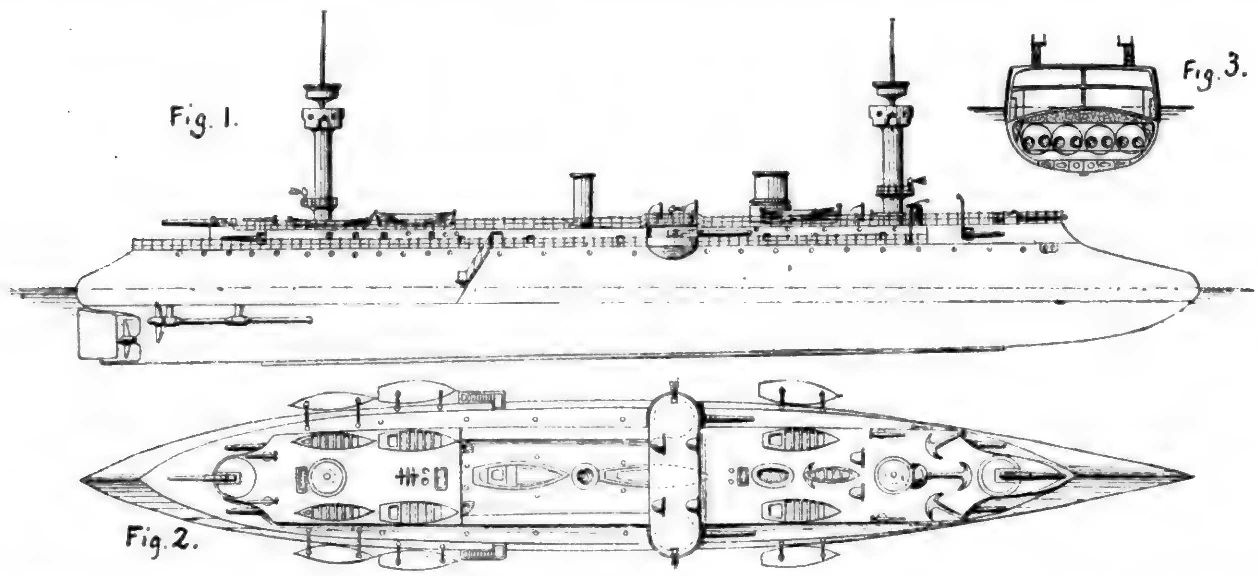
FRENCH ARMORED CRUISERS.

THE *Mittheilungen aus dem Gebiete des Seewesens* in a recent number gives an account of the latest additions to the French Navy, which include armored cruisers of three classes, outline sketches and deck plans of which are given in the accompanying illustrations.

FIRST-CLASS CRUISERS.

Of the first-class cruisers there are three types, the *Alger*, the *Isly* and the *Dupuy-du-Lome*, the last named being a much larger ship than the other two.

The *Dupuy-du-Lome*, shown in figs. 1, 2 and 3, is the only one yet built of its type. It is to be provided with armor which will resist shells loaded with melinite. The general dimensions are as follows:



Length over all	114.00 meters (374 ft.).
Extreme breadth on water line	15.70 meters (51½ ft.).
Depth of hold	6.90 meters (22½ ft.).
Draft forward	6.27 meters (20½ ft.).
Draft aft	7.87 meters (26 ft.).
Draft, mean	7.07 meters (23 ft.).
Immersed cross-section	90.55 sq. meters (974 sq. ft.).
Total displacement	6,296 tons.

The ship is provided with three screws, driven by three compound engines capable of working up to 14,000 H.P., and of driving the ship at the rate of 20 knots an hour.

The armament of this ship is as follows: Two 19-cm. (7½-in.) guns in the casemate on the upper deck, each having a range of 180°; six 16-cm. (6¼-in.) guns, three forward, two being on the upper deck and one on the forecastle, all three trained forward, the other three being aft and arranged in the same way; four 65-mm. (2½-in.) rapid-fire guns, two forward and two aft; four 47-mm. (1 85-in.) rapid-fire guns carried on the military masts, and eight 37-mm. (1½-in.) revolving cannon. The position of these guns is shown in fig. 2.

The ship, which is more of a fighting vessel than a cruiser, is not rigged and has only two military masts.

The *Dupuy-du-Lome* is built from the plans of M. de Bussy, Chief Naval Constructor, and under his direction.

The *Isly* type—of which there are two, the *Isly* and *Jean Bart*—is shown in figs. 4 and 5, while the *Alger* type, of which the *Alger* is so far the sole representative,

is shown in figs. 6 and 7. These two types are cruisers properly so called, and are rigged and provided with sails. The differences in the arrangement of the armored decks, guns, etc., are well shown in figs. 5 and 7.

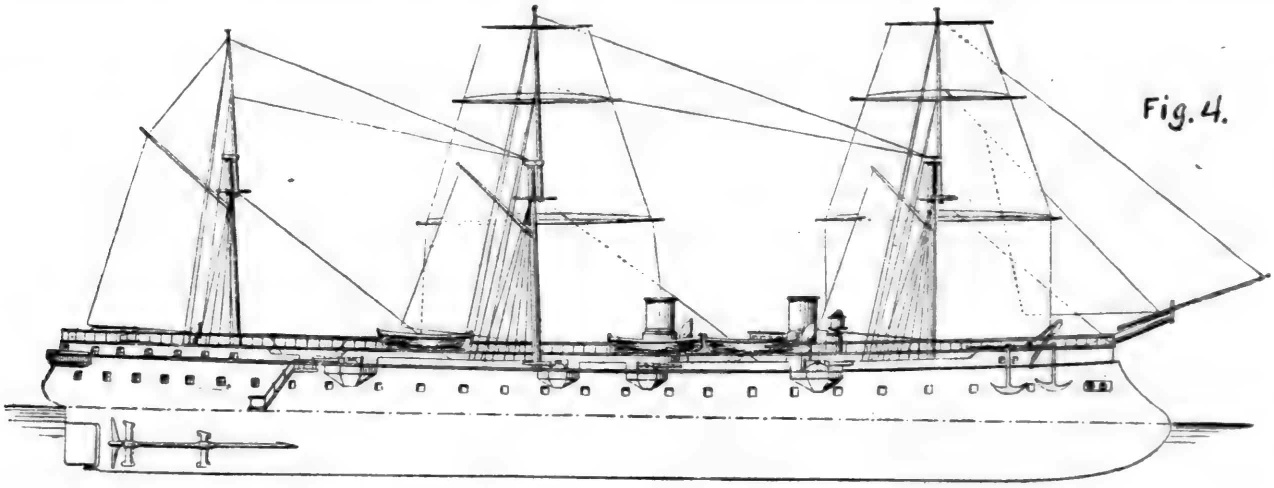


Fig. 4.

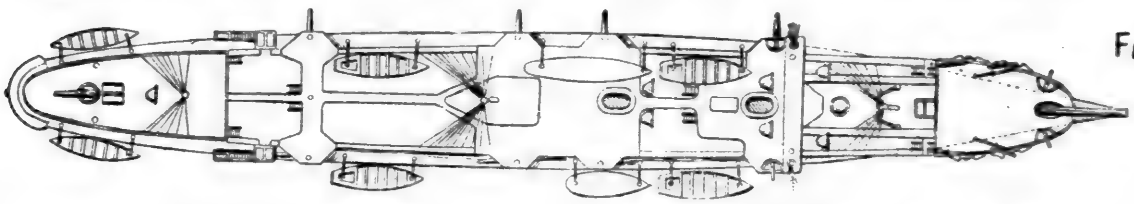


Fig. 5

The dimensions are as follows :

	Isly type.	Alger type.
Total length	105.40 meters.	105.60 meters
Extreme breadth	13.28 meters.	13.80 meters.
Depth of hold	9.30 meters.	9.30 meters.
Draft forward	5.60 meters.	....
Draft aft	6.14 meters.	6.20 meters.
Draft, mean	5.74 meters.	5.50 meters.
Total displacement	4,123 tons.	4,123 tons.

The armament of these ships is not given.

The *Isly* and *Jean Bart*, designed by Chief Engineer Thibaudier, were built at Indret-sur-Loire, and have each

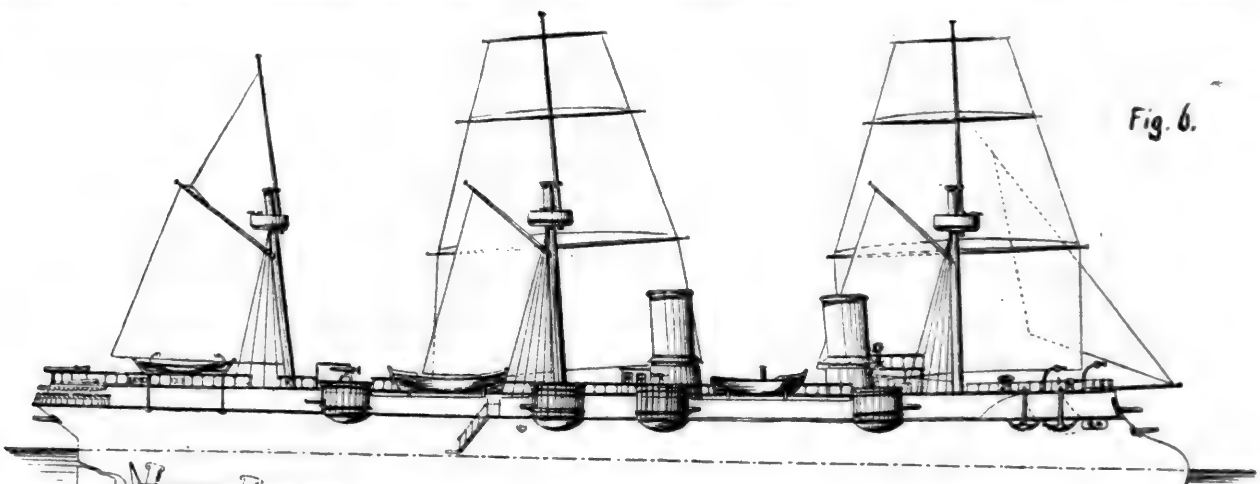


Fig. 6.

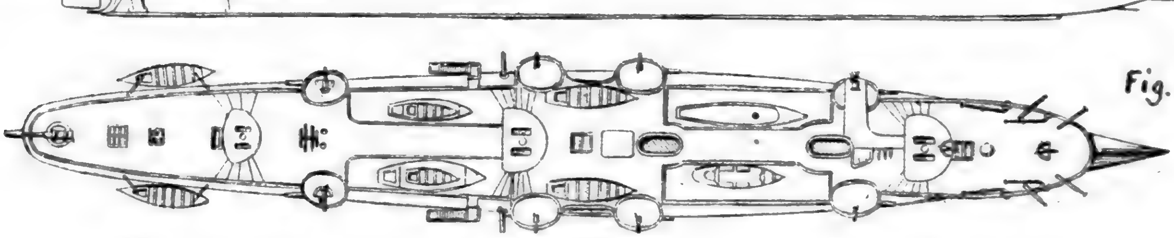


Fig. 7.

two compound engines which will work up to 8,000 H.P. Their highest speed is 19 knots an hour. The *Alger* also has two engines working up to 8,000 H.P.; the ship is being built in the navy-yard at Cherbourg and the engines at Creusot. The *Alger* has boilers of the Belleville type. This vessel was designed by Chief Engineer Marechal.

SECOND-CLASS CRUISERS.

The second-class cruisers are represented by the *Davoust* and a sister ship, the *Souchet*, now under construction in the navy-yard at Toulon, while the engines are being built at Indret-sur-Loire. These vessels, which are shown in figs. 8 and 9, were designed by M. de Bussy, Chief Naval Constructor.

The dimensions of the *Davoust* are as follows :

Length between perpendiculars	88.00 meters.
Breadth over all	12.30 meters.
Depth of hold midships	5.25 meters.
Draft (including false keel) aft	6.15 meters.
Draft, mean	5.35 meters.
Immersed cross-section	55.54 sq. meters.
Displacement	3,027 tons.

This ship will have two compound engines, capable of working up to 9,000 H.P. with forced draft, and of driving the ship 20 knots an hour. With a full supply of coal the cruising radius, at 12 knots an hour, will be 4,000 knots.

The armament will consist of four 16 cm. (6¼-in.) guns —one forward and one aft—on pivot carriages, and two in

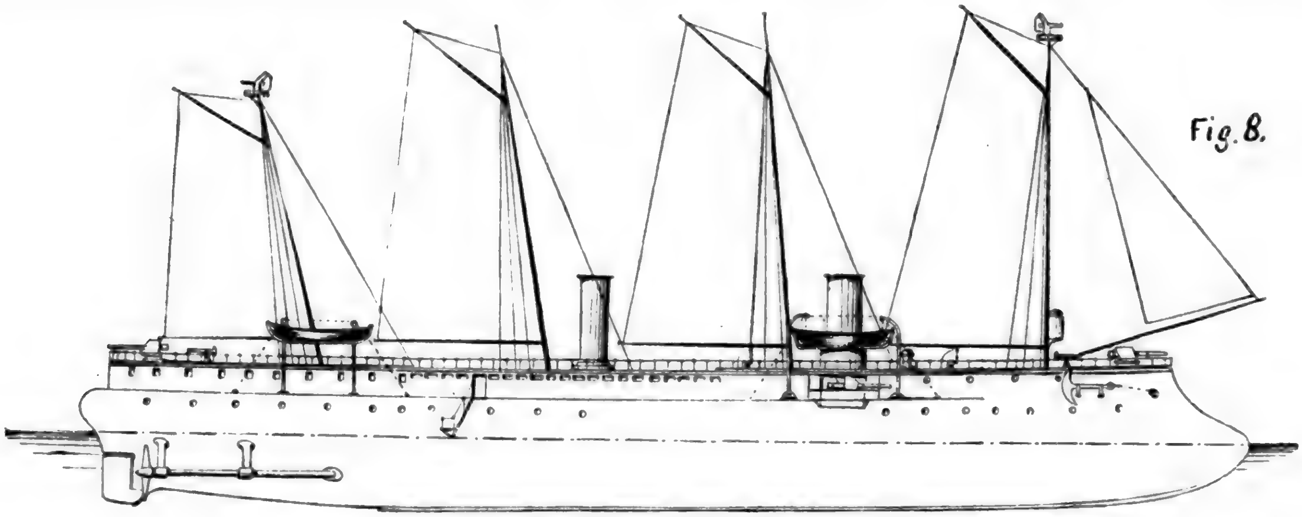


Fig. 8.

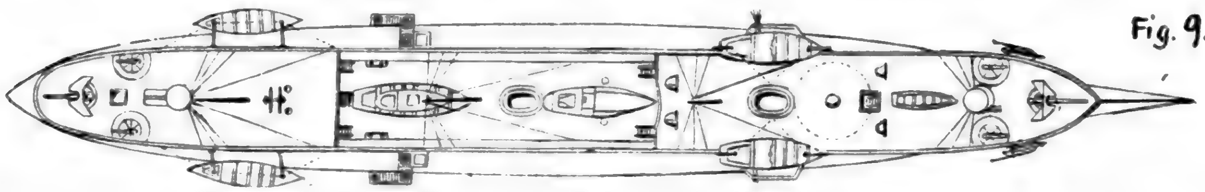


Fig. 9.

the casemate on the upper deck; four rapid-fire guns, two forward and two aft, and six 37-mm. ($1\frac{1}{2}$-in.) revolving cannon mounted in broadside.

Two similar vessels—the *Chanzy* and the *Mogador*—are to be built, the contract for them having been let to the Société de la Loire.

THIRD-CLASS CRUISERS.

The new third-class cruisers are all of the type of the *Forbin*, shown in figs. 10 and 11, and the plans were prepared by M. de Bussy. In all, six of these ships are ordered or under contract. The *Forbin* is building at the Rochefort navy-yard and the *Surcouf* at the navy-yard at Cherbourg; the engines for both are to be built by the Société de la Loire. The Société Transatlantique will build both ship and engines of the *Coetlogon* at Brest, while for the other three—the *Froude*, the *Lalande* and the *Cosmao*—contracts have been let; for the ships to the Société de la Gironde at Bordeaux, and for the engines to the Creusot Works. These three will differ very slightly from the others, having 0.20 meter more beam, 0.07 meter less draft, and 30 tons greater displacement—variances hardly perceptible.

The dimensions of the *Forbin*, the typical ship of this class, are as follows:

Length between perpendiculars	95.00 meters.
Greatest breadth	9.30 meters.
Depth of hold midships	6.54 meters.
Draft aft	5.24 meters.
Draft mean	4.24 meters.
Difference in draft, aft and forward	2.00 meters.
Immersed cross-section	31.27 sq. meters.
Total displacement	1,848 tons.

An armored deck 4 cm. thick extends the whole length of the ship, with a strong armored house or casemate over the engine and boiler rooms, protecting the vital parts of the vessel.

The *Forbin* will have two independent, direct-acting compound engines, and six cylindrical boilers, each with two furnaces; the boilers are arranged in two groups of three each.

These engines can work up to 6,000 H.P. with forced draft, and running at 140 revolutions per minute, it is expected that they will drive the ship at the rate of 19.5 knots.

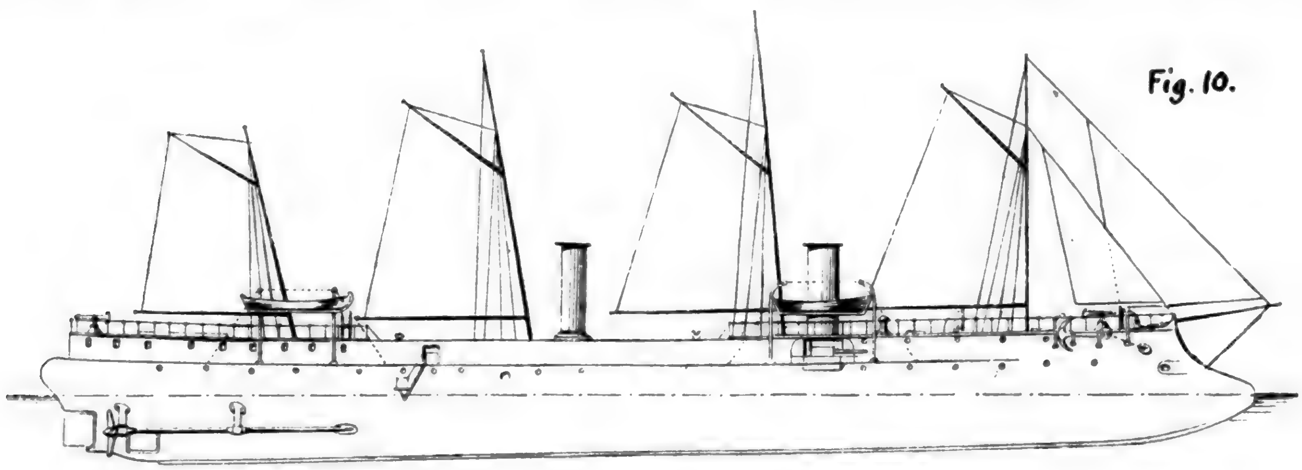


Fig. 10.

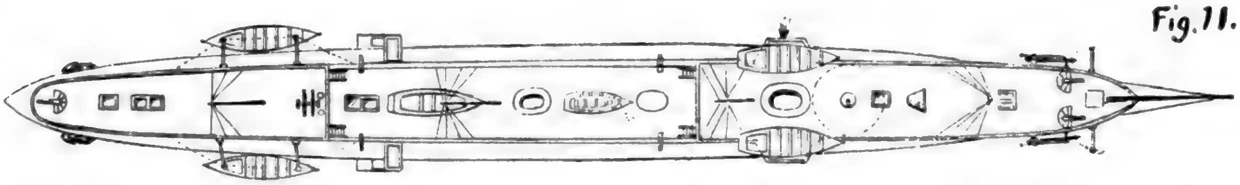


Fig. 11.

With a full supply of coal, and at a speed of 10 miles an hour, the cruising range of this ship is 2,400 knots.

The armament will consist of two 14 cm. ($5\frac{1}{2}$-in.) cannon, mounted on pivot carriages in the casemate forward; three 47-mm. (1.85-in.) rapid-fire cannon, two on the forecastle and one aft, and four revolving cannons in broadside in small turrets.

These third-class cruisers will be, it is expected, very useful vessels, and they will be hurried to completion as fast as possible.

STANDARD TIME AND THE 24-HOUR SYSTEM.

AT the annual meeting of the American Society of Civil Engineers in January, the special Committee on Uniform Standard Time, of which Mr. Sandford Fleming is Chairman, presented an interesting report showing the progress of the Time Reform proposed by the Society. This report is given in full below:

The last annual report of the Committee referred to action which had been taken by the General Time Convention the year previous, with the view of securing an expression of opinion from that Association on the subject of the 24-hour notation.

Circulars had been sent out by the Secretary of the General Time Convention directing attention to the contents of a pamphlet issued by the American Society of Civil Engineers, setting forth the experience which up to that date had been gained on the Central and Mountain Divisions of the Canadian Pacific Railway, where the new notation had been in use for some months. A series of questions also accompanied the circular, to which members of the General Time Convention were requested to furnish replies.

The replies were referred to in the last annual report of this Committee, where, among other things, it was stated that 61 affirmative and 38 negative replies had been received in reference to the question, "Are you in favor of the general adoption of the 24 o'clock system of counting the hours—abandoning the use of A.M. and P.M.?"

It was deemed important to ascertain the precise character of the 38 negative replies, and accordingly application was made to the Secretary of the General Time Convention, Mr. W. F. Allen, for copies of the objections which had been offered. Through the courtesy of that gentleman, the information has been received since the last Annual Meeting of this Society.

An examination of all the replies containing objections shows the following expressions of opinion—viz.:

6 That the A.M. and P.M. system is good enough.

5 That there is nothing to be gained by the change.

4 That the people should be educated to the new system before the railways adopt it.

3 That the adoption of the change would cause great confusion.

2 That it will be impossible to get men to understand the new notation.

2 That it is advisable to delay adopting the new notation until more experience is gained on the railroads now using it.

2 That doubts are entertained if it can be brought about.

2 That its adoption should be delayed until all the railroads are prepared to adopt the change simultaneously.

1 A preference is expresed for the decimal division of the day.

1 That midnight should be designated ZERO or O, in place of 24 hours.

1 Has difficulty in offering any serious objections to the new system.

1 Does not think it concerns the public very much.

1 That it is for the Government to authorize the adoption of the new notation rather than the railroads.

1 Is of opinion that the change would involve great expense.

1 That there will be some objection to the change whenever it may be made.

1 Is not sufficiently familiar with the working of the new system.

The deductions from this analysis are, that of the 99 railroad managers who in April, 1887, furnished replies to the questions placed before them, there were only six who considered the A.M. and P.M. system good enough, and only five who were then unable to recognize the advantages of the new notation. That the objections were not considered very serious by the writers of them is evident from the fact that in 21 of the 38 negative replies, it is stated that they will be prepared to adopt the 24-hour notation if the connecting lines do the same.

The objections which have been raised are met in the most convincing manner by letters from railroad men who have now had from two to three years' daily experience in the use of the new notation in operating railroads. These communications are placed at the service of the Committee and comprise the following—viz.:

15 Letters from managers, assistant managers, superintendents, and assistant superintendents.

7 Letters from train dispatchers.

8 Letters from conductors.

25 Letters from stationmasters.

18 Letters from trackmasters and track foremen.

2 Letters from yardmasters.

There is a singular unanimity of opinion expressed in all these letters in favor of the new system. At present, your Committee cannot do better than submit the two communications which have been last received:

1. A letter from Mr. Collingwood Schreiber, General Manager of the Intercolonial Railway of Canada, dated January 9.

2. A letter from Mr. W. C. Van Horne, President of the Canadian Pacific Railway, dated January 10.

1. Mr. Schreiber's letter is as follows:

"I have your letter of yesterday's date, making inquiry as to whether or not the 24-hour system of time notation is still in use upon the Government Railways, and if so, desiring to be informed if it gives satisfaction.

"In reply I may say, the 24-hour time notation was introduced upon the Intercolonial Railway (906 miles) and the Eastern Extension Railway (80 miles) on June 13, 1887; that it has been in most successful operation from that date to this. I anticipated at the time some trouble in having such a novelty introduced, imagining the public press and the employés of the road would combat it, but such has not been the case; not a word of complaint, so far as I am aware, has appeared in the newspapers upon the subject, and our officers and employés, as a rule, appear to view it as an advancement in the right direction, those employés immediately connected with the movement of the trains especially favoring the system. Under this time notation system no confusion can arise, and for this reason greater safety is assured.

"For my own part I may say I am strongly in favor of the 24-hour system of time notation, and I propose, so soon as the Oxford & New Glasgow Railway (70 miles), and the Cape Breton Railway (100 miles), now under construction, are completed and turned over to the Operating Department, to extend the system to those lines. I think it would be an advantage if it was more generally used by the railways, and I hope, at no distant day, to see its use very much extended; in fact, it appears to me it would be a great advantage if the railway managers throughout the Continent would put the 24-hour system of time notation in operation upon their roads; it certainly could not but be fraught with good results. I may, however, remark that I do not think the public will readily take it up for general use until such time as it is taught in the public schools; if this was done, I believe it would very soon come into use for all purposes."

2. Mr. Van Horne's letter is as follows:

"Replying to your note of the 6th instant, I am happy to be able to say that our nearly three years' trial of the 24-hour system on all of our lines west of the Great Lakes, embracing 2,354 miles, has been highly satisfactory. No confusion whatever resulted from its adoption or has grown out of its use, and I have yet to hear of the first objection to it on the part of the public.

"The Manitoba & Northwestern Railway Company, 207 miles, and the Northwestern Coal & Navigation Company's

railway, 110 miles, also follow this system. It is, therefore, the only system used for railway purposes north of the 49th parallel and west of the 89th meridian.

"We hope soon to be able to extend this system over all the company's lines in the East. We should have done so before this time, if some of our neighboring lines had been in a position to join us in the movement.

"A short experience with it must, I believe, convince anybody that it is vastly superior for railway purposes to the old system. It takes a surprisingly short time to come to think of 20 o'clock instead of 8 o'clock P.M.

"There is no danger in its adoption, even on a very busy line. The term 19:47, for instance, in a train order, cannot be mistaken for anything else."

CONCLUSIONS.

These letters conclusively establish that the new notation has been thoroughly tested for two or three years on 3,657 miles of railway; that no difficulty whatever has been experienced in introducing the change; that it has been readily accepted by the public without a single objection being heard; that its extreme simplicity and the impossibility of errors resulting from its use facilitates the movements of trains and promotes the public safety. The new system having thus proved so satisfactory in every way, it has now been determined to employ it on 3,053 additional contiguous miles, which will make a total length of 6,710 miles of railroad shortly to be operated under the new notation.

It is obvious that there can no longer be any doubt as to the practical advantages of the new system, and the ease with which it can be applied to the operating of any line of railroad. The negative replies which have been cited cannot be said to present insuperable difficulties, and it is believed that the writers of them will now have their views greatly modified by the experience which has been gained, and the explanations made in the more recent letters which have been submitted.

Your Committee cannot but think that in the public interest it is advisable that renewed efforts be made to secure the general adoption of the new notation.

TRANSITION CURVES.

By Charles Davis Jameson, C.E.

In laying out a line of railroad, the angles formed by the meeting of two adjacent tangents are rounded off by means of a curve of some class of sufficiently long radius and of proper form to allow of the free passage of trains without danger and with a minimum of inconvenience.

A circular arc is the form of curve most generally used, and the methods employed in laying it out have been fully explained in Chapter XIX., "Principles of Railroad Location," published in the Journal for May, 1888.

Curves of other forms, such as the parabola, have been used to some slight extent, but the various disadvantages connected with their use are such that the circular curve, with some slight modifications, will continue to be *the* railroad curve. The advantages of this curve over any other for railroad work are as follows:

1. The change of direction is uniform throughout its whole length.

2. The ease and facility with which it can be laid out in the field.

Any body, such as a railroad train, acted on by one force only, tends to move in a straight line, and it requires another constant force acting at an angle with the original force to cause the body to move in a curved path.

In the case of a railroad train, the curved path is defined by the rails to which the train is held by means of the wheel flanges, and the change of direction in the train in passing around a curve is effected by means of these flanges pushing against the outside rail. The amount of this pressure is the force required to make the train follow the curve, and thus overcome the tendency it has to move in a straight line, or the centrifugal force. The amount of this pressure varies with the speed of the train and the radius of the curve. The formula for it is:

$$F = m\frac{v^2}{r} \qquad (1)$$

$F =$ the centrifugal force.
$r =$ the radius of the curve at the given point.
$v =$ velocity of train in feet per second.

The value of F varies with r, and when r is constant F is constant also. Therefore F, or the amount of pressure on the outside rail, is constant throughout a circular curve. This centrifugal force not only causes a pressure of the wheel flanges against the outside rail, but as the center of gravity of the car is much above the point of support, there is a tendency to turn over toward the outside rail.

In order to reduce somewhat this pressure of the flanges against the outside rail, and also to eliminate the danger of the cars being turned over by centrifugal force, it is the universal custom to raise the outer rail on a curve a certain distance above the inner one.

When the outer rail has a greater elevation than the inner one, the tendency of the train will be to turn over on the side of the lower rail, which in the case of curves would be toward the inside of the curve. When a train is passing over a curve at a certain velocity, this velocity, together with the change of direction of the curve, produces a certain amount of centrifugal force which tends to turn the train over toward the outside of the curve. The theoretical amount of superelevation to be given to the outside rail is such that, at the assumed velocity of the train, these two forces, one throwing the train to the inside of the curve and one to the outside, will exactly counterbalance each other, and the train will remain in perfect equilibrium while passing around the curve.

In other words, the lateral component of gravity thus introduced by the superelevation of the outer rail will approximately balance the centrifugal force due to the speed of the train and the radius of the curve. The theoretical elevation to produce this effect is given by the equation:

$$E = \frac{g\,v^2}{32.2\,R}.$$

Here E is the superelevation, v the velocity of the train in feet per second, g the width of gauge, and R the radius of curvature.

From this it can be seen that the superelevation is constant for constant values of D or r.

In actual practice the amount of superelevation that may be given to the outer rail is limited, for the following reasons:

1. The unavoidable variation in the speeds of the different trains, and the fact that when the superelevation becomes too great there is a tendency for slow freight trains to become derailed upon the inside of the curve.

2. That no matter how much superelevation is used, there is a safe limit beyond which trains cannot be run. This is due to the fact that the car-bodies rest upon springs, and, as the centrifugal force increases, the pressure upon the outside springs increases and they become compressed by a certain amount. As the speed increases, this compression increases, until at last a speed is reached that upon a given curve generates sufficient centrifugal force, and by it sufficient compression upon the outside springs to force the car-body into the same position it would have if there were no superelevation and no curve. The result of this is to reduce the limit of safe speed, and, as the amount of centrifugal force that can with safety be generated is limited by the stiffness of the springs, there is no necessity of any more superelevation than is required to balance this allowable amount of centrifugal force.

The limit that is adopted upon railroads varies from 6 to 10 in. A maximum limit of 8 in. can be taken as approximately correct.

As a rule of thumb to be memorized by the engineer: *The superelevation should be one inch per degree of curvature up to the maximum limit.*

Beyond this limit the speed of the trains should be reduced in order to reduce the centrifugal force.

This amount of superelevation is somewhat in excess of what is generally used, but, owing to the rapid increase that is being made in the speed of trains, it will be found none too much.

For the use of track men who do not know the degree, or radius, of the curves, but have the curves themselves

in the shape of the rails, it is often convenient for them to know the length of the chord in feet, the middle ordinate of which is the correct superelevation of the outside rail. The length of this chord that gives a middle ordinate of 1 in. per degree of curvature is 61.8 ft.; or *four times the middle ordinate of a 30-ft. rail will give approximately the same result.*

In order to obtain the correct superelevation of the outer rail, carefully mark two points upon the inside of the head of the outside rail. The distance between these two points is to be equal to the required length of chord—61.8 ft.

Stretch a small cord tightly between these points, and from the middle point of this cord measure the distance from the cord to the inside of the head of the rail, and this distance will be the correct superelevation of the outside rail.

As we have seen, the amount of this superelevation is uniform for the whole length of a circular curve.

If any curve other than a circular curve is used, the radius of this curve will vary from point to point, and, consequently, the required amount of superelevation of the outside rail will also vary in the same proportion.

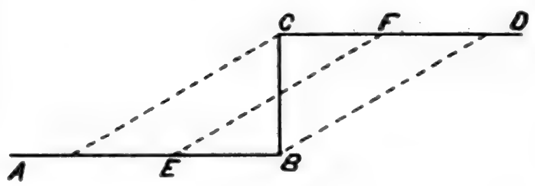


Fig. 5.

Fig. 6.

This would necessitate not only a great increase of work and care upon the part of the section-men to give this correct but varying amount of superelevation, but it would be practically impossible to so put the track up as to eliminate all shocks and irregularities in the trains.

In this fact consists the great advantage of the circular curve, and this, taken in connection with the ease and facility with which they can be located, will always insure their general use.

The circular curve, however, as generally used, possesses the following disadvantages :

The superelevation of the outside rail being constant for the whole length of the curve, at the point where the curve begins the outside rail should have the full superelevation, as *C B*, fig. 5, but upon a tangent both rails have the same elevation, and, consequently, to conform with theory, the entire superelevation should be made at one point, and that at the beginning of the curve. This, of course, is an impossibility, as it would create a step in the profile of the outside rail.

This difficulty is obviated to some extent by one of the three following methods :

1. The superelevation may begin back a sufficient distance upon the tangent to allow of the requisite amount being attained by the time the curve commences, as *A C*, fig. 5.

2. The superelevation may begin at the point of curve, and be increased as rapidly as possible until the requisite amount is attained at some point on the curve, as *B D*, fig. 5.

3. The superelevation may begin a sufficient distance back on the tangent to allow of about one-half the requisite amount having been attained when the point of curve is reached, and this amount to be gradually increased until the full requisite amount is attained at some point in the curve, as *E F*, fig. 5.

These are only partial remedies. The first has the objection of making one rail higher than the other upon a tangent, which causes the train to crowd against the lower side.

The objection to the second is that a portion of the curve at each end has a very insufficient amount of superelevation.

In the third there is about half the objection of the first plus half the objection of the second, and any way it can be adjusted, there exists in some form about the same amount of evil in regard to the superelevation of the outside rail, when the circular curve is joined directly to the tangent.

There is also not only the trouble in regard to the superelevation of the outside rail, and the shock and jar thereby caused the train, but where the circular curve is joined directly to the tangent the change of direction in the case of a sharp curve is relatively so great at the point of curve as to cause a great shock to be felt in the train, no matter what the elevation of the outside rail may be. This in some cases is so great as to become a source of real danger.

After the train has passed entirely upon the curve and the proper superelevation is once attained, then it is in as perfect equilibrium as upon a tangent, and there is no cause for any inconvenience or unsteadiness in the running.

These two disadvantages connected with the use of circular curves are confined to portions only of the curve near and at its ends, and are due to the fact that the circular curves are joined directly to the tangent. They exist simply in regard to a too sudden change in direction, and in the impossibility of giving the outer rail the correct superelevation at the right point. In order to obviate these evils, TRANSITION, or EASEMENT CURVES have been introduced, by means of which the circular curves are joined to the tangents.

The necessity and utility of easement or transition curves is very readily seen if a careful examination is made of a piece of road that has been built for a number of years, over which there has been the passage of a great many trains, and which has been lined all the time by section-men. It will always be found that although the curves in the beginning were perfect circular curves, joined directly to the tangent, still, as time goes on, the circular curves near each end invariably become changed into a rude form of transition curves. This is due to the impact given to the outside rail at the beginning of the curves by the sudden change in the direction of the train, and also to the gradual easing off of the curve unconsciously done by the track-men. In any easing off of the ends of a circular curve that has been joined directly to the tangent, while at the point of curve the radius may be increased somewhat, this increase can only be effected by a proportional shortening of it at some point beyond, and thus what is gained at one point is nearly all lost at another. As an example showing how universal is this unconscious introduction of easement curves upon old roads, the Author once had occasion to make a survey of 271 miles of railroad which had been operated some 25 years. A survey was made with the object of getting the alignment exactly as it was at that time, and all the curves showed clearly upon being plotted that their ends had been eased off, and a sharp point created a certain distance beyond on the curve. This was the case without exception upon every curve. In some cases the track, by means of the impact given by passing trains, and the help given to this impact by the section-men, had been moved a distance of three

or four feet from its original position, thus necessitating a continual widening of the road-bed upon the outside of the curves near their ends.

This excessive width of road-bed at these points was the first thing that called the Author's attention to the fact.

This establishes beyond a doubt the necessity and economy of some class of easement curve, but does not introduce one that in every way conforms with the required conditions. An immense amount of wear, tear, and time are necessary in this method of introducing them. Some method must be found that shall conform practically and theoretically with the required conditions, by means of which the rails may be laid in the proper position in the beginning.

The necessity of the transition curve was not so marked in the early days of railroading as at present, owing to the extremely slow rate of speed at which most of the trains

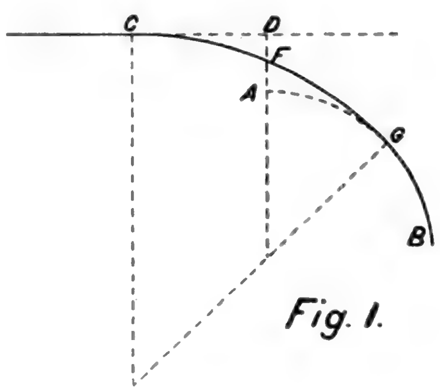


Fig. 1.

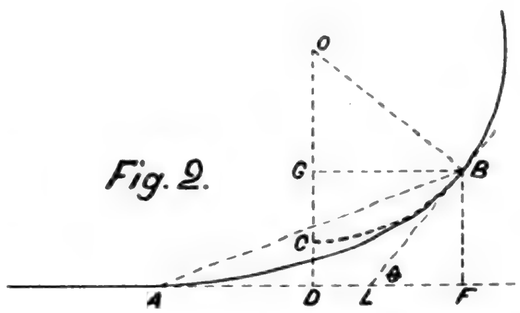


Fig. 2.

were run, but with the speed of the present day they are almost an absolute necessity.

A theoretically perfect transition curve should possess the following properties :

1. Beginning with a radius that is practically infinity, this radius should gradually decrease until it becomes equal to the radius of the desired circular curve.

2. The radius of a transition curve should vary inversely as the distance from the starting-point, although not necessarily in exactly the same inverse ratio.

These are the theoretical requirements, and to these should be added the following practical requisites :

Every transition curve of whatever form consists essentially of the following parts, fig. 1 :

The tangent *C D* is run up to a certain point, as *D*, where it is desirable to put in a curve, and then instead of the circular curve being connected directly with the tangent, it is moved in so as to form an offset, as *D A*, and the circular curve occupies the position *A G B*. The transition curve connects this circular curve with the tangent. It starts at some point on the tangent back of *B*, such as *C*, it passes approximately through the middle point in the offset *F*, and is tangent to the circular curve at some point beyond *A*, as at *G*.

All transition curves are of this form, more or less, and the most important practical point to be considered is that the offset *D A* should not be of any fixed length for a circular curve of a given radius, but should be capable of being varied in length to suit more nearly the surface of the ground. This fact, that the offset *D A* is not fixed in length by the radius of the circular curve, not only allows of the line being fitted more accurately to the ground when first run, but also renders it possible to change the position of any portion of the line afterward without the necessity of rerunning and changing all that has gone before or after.

That is, if after the final location has been made and the circular curves run in, it is found that the line can be improved by changing the position of any of these circular curves, within certain limits, or by changing their radius, any of these changes can be made without changing the position of the tangents at each end of the curve. The only change that would be made would be in the length of the offsets, and the transition curves should be so arranged that for any length of offset and any radius of curve, one could be run in with no more work than is required to run in so much circular curve. Any system of transition curves that has the above property is not only a great advantage to the road when finished in regard to the cost of operation, but also gives a flexible, elastic line that in the location can be lengthened or shortened, moved from one side to the other to conform with the configuration of the ground, and only that part of the line affected that is actually moved.

It is from this standpoint that the following system of transition curves possesses advantages over all others that have been presented to the engineering profession, so far as the Author knows. None of the innumerable varieties of transition curves have possessed this quality of flexibility, with the exception of the "circular easement curve," fully described on page 249, in the number for May, 1888, of the RAILROAD AND ENGINEERING JOURNAL. It consists simply of a circular arc of a larger radius than the curve with which it is used, connecting the tangent and circular arc and tangent to both. This curve, strictly speaking, is an "easement curve," nothing else. It possesses all the inherent evils of the circular curve when joined directly to the tangent, as far as the superelevation of the outer rail is concerned, and there is also this same difficulty at the point where the "easement curve" joins the circular curve. The only advantage it possesses in this respect is that the evil or difficulty, although not much reduced as a total, still is distributed at two points—*i.e.*, where the "easement curve" leaves the tangent and where it joins the main circular curve, instead of being concentrated at the point of curve, as is the case when the circular curve alone is used.

The advantages it has are that it renders the line perfectly flexible and elastic, and also the extreme simplicity with which it is used in the field.

(TO BE CONTINUED.)

THE STRONG LOCOMOTIVE.

A REMARKABLE test of the capacity of this locomotive for continuous work was recently made. On April 1 the locomotive *A. G. Darwin*, owned by the Strong Locomotive Company, which has been running for some time on the New York, Lake Erie & Western Railroad, started from Jersey City with the regular day express of that road, and made the run through to Buffalo, 423 miles. This is the longest continuous run ever made with one locomotive of which we have any record, with the exception of a trip from Jersey City to Pittsburgh, which was made with a single locomotive some years ago. On the following day, April 2, the *Darwin* made the return trip from Buffalo to Jersey City in the same way.

On both days the engine arrived at its destination in excellent condition, requiring no repairs whatever, and apparently in condition to go out again at once. The trip also was made in both directions on time, in spite of delays caused by stopping to take on coal, and one serious delay

on the west-bound trip caused by the necessity of pushing a disabled freight train, which was overtaken, to the next siding. The coal was that ordinarily burned on the road, and was not of very good quality. In fact, it clinkered considerably, and on the arrival in Jersey City the second day, the tube sheet was found to be badly coated with clinkers, thus impairing the draft considerably.

The ability of the engine to keep an abundant supply of steam, as it did throughout these long runs, was undoubtedly due to the double fire-box, which is the distinguishing characteristic of the boiler, and which enables the fireman always to have one good clear fire in use, no matter how poor the condition of the other might be. The figures for time, distance, etc., from the official record are given below:

On the westward trip the Eastern Division from Jersey City to Port Jervis (87½ miles) was covered in 151 minutes, or 6 minutes less than schedule time; the Delaware Division, from Port Jervis to Susquehanna (104½ miles), in 166 minutes, or 11 minutes less than schedule time; the Susquehanna Division, from Susquehanna to Hornellsville (139¾ miles), in 187 minutes, or 20 minutes less than schedule time; and the Buffalo Division, from Hornellsville to Buffalo (92½ miles), in 130 minutes, or 27 minutes less than schedule time. All of the above times are those of actual motion. The first is at an average speed of 34¾ miles per hour, the second 37¾ miles per hour, the third 45 miles per hour, and the fourth 42½ miles per hour. The total time made up westward was 64 minutes. Callicoon, on the Delaware Division, was left 20 minutes late, going west, on account of the disabled train above referred to, 18 minutes of which were made up on arrival at Susquehanna, 56½ miles distant. Hornellsville was left 20 minutes late, on account of delay in taking coal. Other delays occurred on the Buffalo Division, but the schedule time was struck near Alden, 19½ miles east of Buffalo.

On the eastward trip, the Buffalo Division was covered in 155 minutes, the Susquehanna in 208 minutes, the Delaware in 159 minutes, and the Eastern in 141 minutes. The times made up were respectively 8, 18, 21, and 13 minutes, or 60 minutes in all. The fastest mile noted was made in 55 seconds, and many were made in 60 seconds each. On the Delaware Division the distance from Callicoon to Hancock, 28 miles, was covered in 34 minutes, and from Hancock to Deposit, 13 miles, in 20 minutes, the grade being up. On the Susquehanna Division the distance from Binghamton to Union, 8.6 miles, was covered in 12 minutes; from Union to Owego, 13.4 miles, in 17 minutes; from Owego to Waverly, 19.1 miles, in 23 minutes; from Waverly to Elmira, 17.6 miles, in 22 minutes, and from Elmira to Corning, 17.3 miles, in 25 minutes. On the Buffalo Division the distance from Hornellsville to Canaseraga, 12.5 miles, was made in 18½ minutes; from Castile to Warsaw, 10 miles, in 15 minutes; Warsaw to Attica, 17.2 miles, in 22 minutes.

On the eastward trip some of the speeds are as follows: Susquehanna Division, Canisteo to Addison, 25.9 miles, in 35 minutes; Addison to Corning, 11.1 miles, in 18 minutes; Corning to Elmira, 17.3 miles, in 24 minutes; Elmira to Waverly, 17.6 miles, in 23 minutes; Waverly to Owego, 19.1 miles, in 24 minutes; Owego to Union, 13.4 miles, in 19 minutes. On the Delaware Division rates of speed were as follows: Deposit to Hancock, 12.7 miles, in 18 minutes; Hancock to Callicoon, 28.2 miles, in 36 minutes; Cochecton to Lackawaxen, 19.9 miles, in 26 minutes. All of the above intervals are from a start to a stop.

The trains consisted of the following cars and weights, without the locomotive and passengers: Jersey City to Port Jervis, 6 cars, including 2 Pullmans, weighing 132 tons; Port Jervis to Elmira, 7 cars, including 2 Pullmans, weighing 154 tons; Elmira to Hornellsville, 9 cars, including 3 Pullmans, 214 tons; Hornellsville to Buffalo, 7 cars, including 3 Pullmans, 209 tons; Buffalo to Hornellsville, 8 cars, including 3 Pullmans, 233 tons; Hornellsville to Elmira, 11 cars, including 5 Pullmans, 335 tons; Elmira to Jersey City, 9 cars, including 4 Pullmans, 274 tons. The locomotive weighs 68 tons in working order, and the tender 40 tons, full of coal and water.

The maximum grades encountered were 8 miles of 60 to 90 ft. per mile from Susquehanna eastward, and one of 54 ft. per mile for 13 miles from Port Jervis eastward, both of which were ascended without assistance.

EXPERIMENTAL GUNS FOR THE ARMY.

THE late Congress appropriated $6,000,000, to be expended at the rate of $2,000,000 a year in the purchase of new guns for the coast defenses. Under the act a Board on Ordnance and Fortification was appointed to decide on the method of using the appropriation. The act provides that this Board shall prescribe the dimensions and method of testing guns of 10 or 12-in. caliber that may be submitted by private parties, and if any gun offered shall fulfill the requirements as to accuracy, range, power, endurance, and general efficiency, then the gun and ammunition (which is to be furnished with the gun) shall be paid for at a fair valuation, including cost of transportation. A contract is also to be made at reasonable prices with the party presenting the best of such guns for a further supply.

The Board has prepared and published rules to govern the tests, which are as follows:

RULES.

1. The 10-in. gun shall be about 30 tons (long) in weight, the length 34 calibers, measured from the face of the obturator to the face of the muzzle. It is desirable that the trunnions be 12 in. in diameter and the distance between rim bases 42 in., in order to avoid the necessity for a special carriage. The power must be a muzzle energy of not less than 15,000 foot-tons; the range shall, for 20° elevation, be 13,650 yards, and corresponding ranges shall be obtained with lower elevations. The requirements as to accuracy are that 25 per cent. of the shots shall strike within a vertical rectangle, 1.4 ft. by 1 ft. at 1,500 yards' range, and within a horizontal rectangle, 48.5 yards by 9.2 yards at 10,000 yards' range.

2. The endurance test should not be less than 300 rounds with full charges. After 250 or more rounds may have been fired, the gun may be lined wholly or in part, when at least 50 rounds more will be fired to fully test the strength of the construction. After this the general soundness and efficiency of the gun should not be materially impaired, except so far as may have resulted from erosion. Should any material modification of the construction be made during the trial, at least 50 rounds, with full charges, shall be fired thereafter. The weight of projectile to be used with the full charge shall be about 575 pounds. Three hundred rounds of ammunition shall be the "proper" amount to be supplied with the gun for test.

3. As a proof of general efficiency, the breech mechanism should work freely and be convenient for operating, the opening and closing of the breech to be performed without great difficulty by one man. The projectiles shall admit of being readily handled, inserted and centered in the bore and not be subject to injury or deformation either in handling or transportation. A rapidity of fire of 15 rounds per hour shall be attainable, using such appliances for loading as are employed by the Ordnance Department, United States Army. The repairs allowable during the entire trial of a gun, exclusive of the insertion of a lining tube, will be confined to repairing or renewing parts injured during trial. No alterations that may affect the general construction of any part will be made without the sanction of the Board.

4. For the 12-in. gun the weight is to be about 52 tons, the bore 34 calibers long, and it is desired that the trunnions be 14.5 in. in diameter and 49.8 in. between rim-bases. The power is to be not less than 26,000 foot-tons, the range 14,700 yards at 20° elevation; the accuracy the same as the 10-in. gun, endurance not less than 250 rounds (a lining may be inserted after 200 rounds), the weight of projectile about 1,000 pounds, and the other conditions are to be the same as in the case of the 10-in. gun, except that a fire of 10 rounds per hour shall be attainable.

5. The experimental guns should be submitted for test as soon as practicable and within three years from date.

It is not considered practicable for the Board to determine at this time what will be a "fair valuation" of

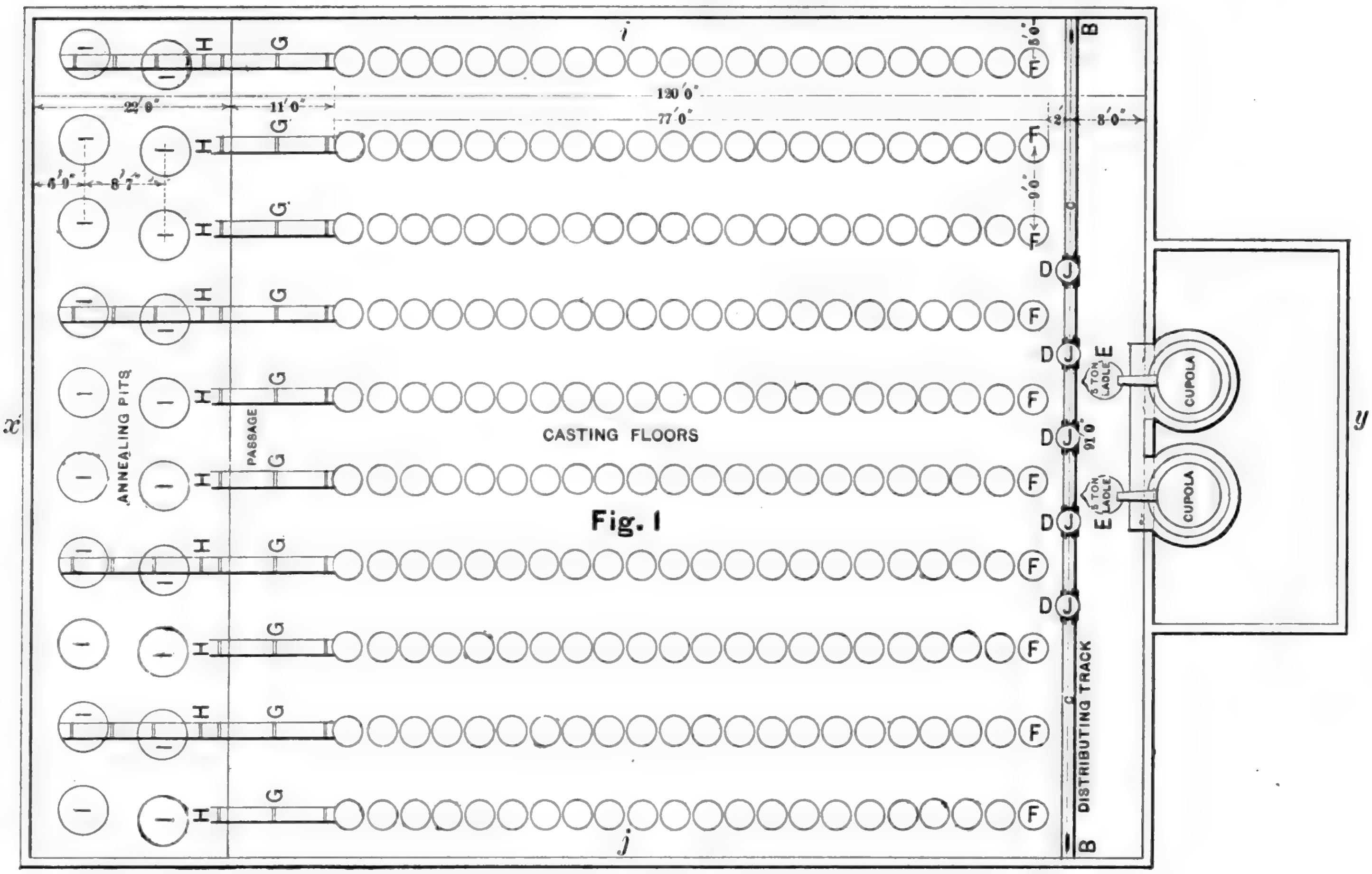
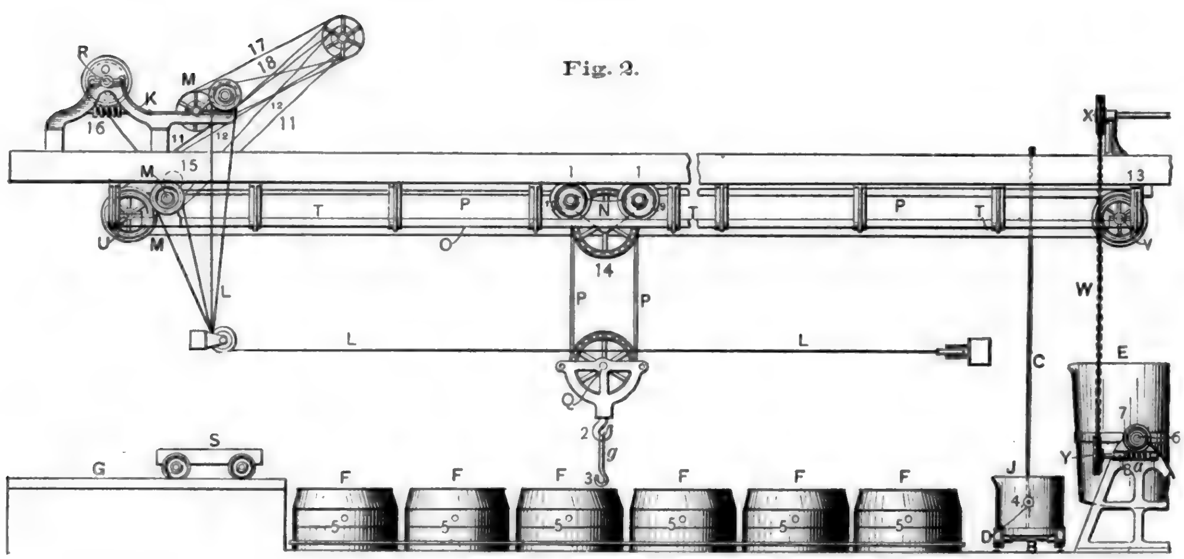


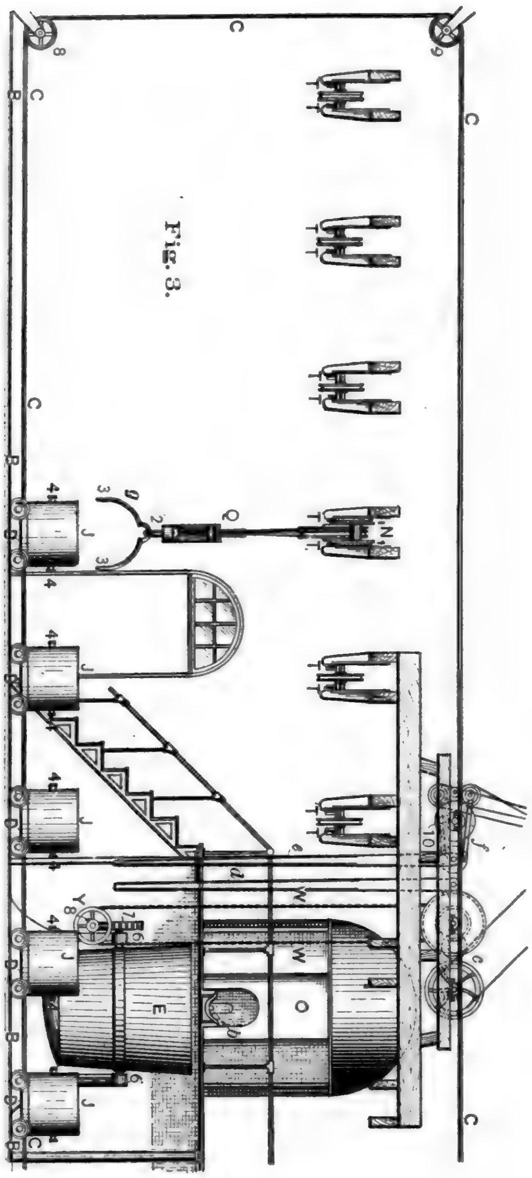
Fig. 1

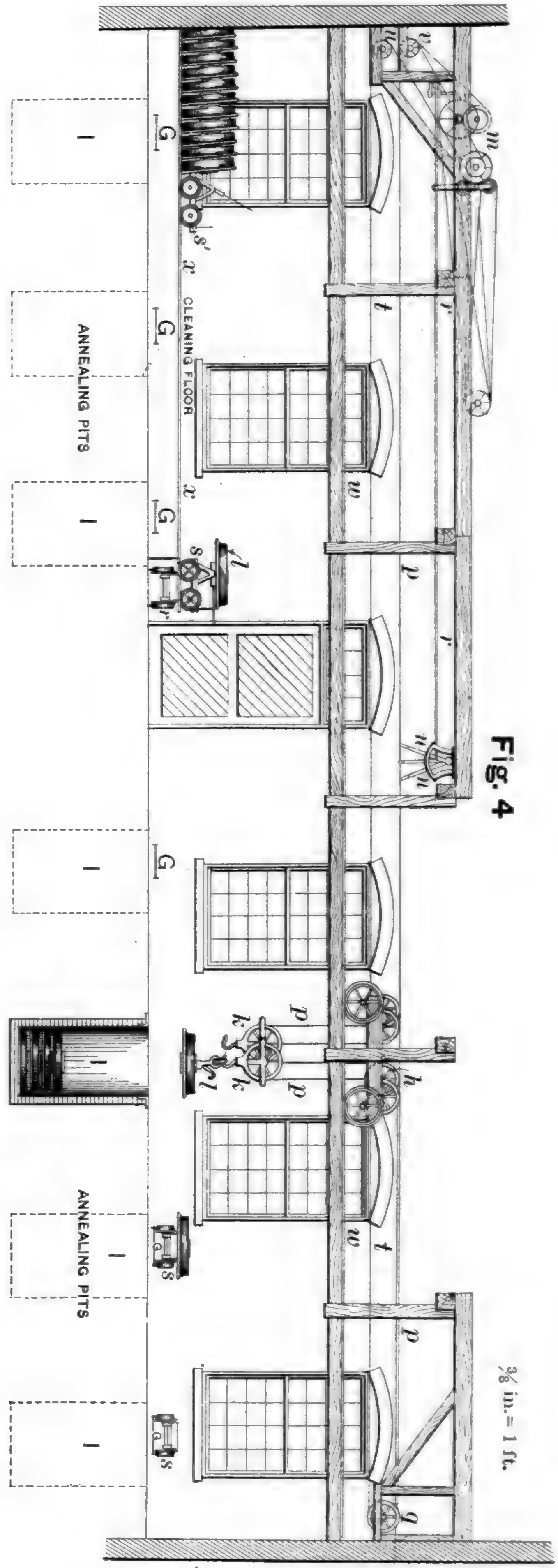
Fig. 2.



CAR-WHEEL FOUNDRY PLANT,

BY THE DETROIT FOUNDRY EQUIPMENT COMPANY.





CAR-WHEEL FOUNDRY PLANT,
BY THE DETROIT FOUNDRY EQUIPMENT COMPANY.

an experimental gun which shall have fulfilled the requirements prescribed, nor what price would be "reasonable" for a further supply of similar guns. It is believed to be better on all accounts to leave these questions for determination after the actual cost and value of such guns can be known, it being understood as the duty of the Board to act in such matters with entire impartiality as between the United States and any party who shall attempt to supply the desired guns. It is understood, however, that the Board is disposed to deal in a liberal spirit with parties submitting guns, with a view to carrying out the evident purpose of the act of Congress, which was to encourage the development in the United States of works capable of supplying the needs of the country in the way of sea-coast and other kindred defenses.

WHITING'S IMPROVED CAR-WHEEL FOUNDRY PLANT.

THE engravings, figs. 1, 2, 3 and 4, on the preceding pages, represent the foundry car-wheel plant, which is the invention of Mr. J. H. Whiting, of Detroit, and is in use in the wheel foundry of the Detroit Car Wheel Company of the same place. This plant is manufactured by the Detroit Foundry Equipment Company, also of Detroit.

Fig. 1 represents a plan of a wheel foundry equipped with this plant; fig. 2, a transverse section on a line *x y* of fig. 1; fig. 3 is a section on a line *i j*, looking toward the right-hand side of fig. 1, and fig. 4 is a section on the same line, but looking toward the left-hand side of fig. 1. Figs. 2, 3 and 4 are engraved to a larger scale than fig. 1. The same letters designate like parts in the different views.

The flasks *F F F*, for casting the wheels, are arranged in rows, as shown in fig. 1. Two cupolas for melting the iron are shown, but one only is needed. They are placed in an annex to the main building, on the right-hand side, as shown in the plan.

The plant consists of a system of tracks and overhead traveling cranes or "runways" for handling the melted iron and the wheels after they are cast, all of which is operated by machinery. *E E*, figs. 1, 2 and 3, are 5-ton receiving ladles into which the iron is tapped from the cupolas. *J J J* are small ladles into which the melted iron is poured from the large ladles *E E*. *B B* is a narrow-gauge track, laid on the floor of the foundry in front of the cupolas, running crosswise to the rows of flasks *F F F*, and extending the entire width of the foundry. Small cars or "buggies," which carry the ladles *J J J*, run on this track, and deliver the melted iron from the large ladles *E E* to the different rows of flasks *F F F* on the floor. These buggies are coupled together into a train, the couplings being of such a length that when one car is standing opposite to the space or aisle between the rows of flasks all the others in the train will be in a similar relation to the flasks. *G G G* are short iron tracks, which connect the rows of flasks with the wheel-annealing pits *I I I*. The portion over the wheel pits is movable, and is separated from *G G G* at *H H H*, which allows the part over the pits to be moved as desired or as may be necessary.

Over each row of flasks, and also over each aisle between them, is a pair of suspended rails *T T*, figs. 2 and 3, which run at right angles to the track *B B*, and are supported by hangers attached to the roof framing. These rails extend all the way across the foundry floors, from the track *B B* to the wheel-annealing pits *I I I*, fig. 1. Each of these pairs of rails has a buggy or traveler, *N*, with four wheels 1 1, which run on the rails *T T*, so that it can travel over the whole length of the rails. A sheave or pulley, *Q*, is carried by the buggy *N*, and is suspended by a wire-rope *P P P*, by which it can be raised or lowered.

As explained, the melted iron is tapped from the cupola into the large ladle *E*, and from it is poured into the small portable ladles *J J J*, which are carried on the cars *D D D*. The buggy *N* is then run so as to come immediately over the track *B B*. The sheave *Q* has a hook 2, to which a bail *g* is attached. This also has hooks 3 3, which engage with the trunnions 4 4 on the ladles *J J*, so that the ladles can be raised up by means of the wire-rope *P P*. The buggy is then run on the overhead track to any of the flasks in the row, and by attaching suitable handles to the ladle the iron is poured into the flask as may be required. As each overhead track has a buggy, all the ladles on the cars *D D D* can be handled simultaneously.

When the wheels are cast the flasks are lifted by their trunnions 5 5 5, and a suitable clamp is attached to the hot wheels, which are transferred to trucks *S*, figs. 2 and 4, which run on the tracks *G G G*, and convey the wheels to the pits. Over these pits is another suspended track *w w w*, fig. 4, similar to *T T T*, but at right angles to it, on which other buggies or travelers *h* run, and which also have suspended sheaves or pulleys *k k* that are operated by wire ropes. The wheels are lifted by these from the trucks *s*, and transferred by running the buggy *h* on the overhead track to any of the pits desired. The ropes *p p p* are made of sufficient length, so that the wheels can be lowered or raised to or from the bottoms of the pits after they are annealed. *ss'*, fig. 4, represents a truck which travels at right angles to another truck *r*, on which it can be run as shown, and transferred to any desired location. If a wheel is loaded on *s*, it can be transferred to any one of a number of parallel tracks *x x*, by means of the truck *r*; *s* can then be run on the track *x x* to the position *s'*, and by a very simple movement a portion of the truck can be tipped up, which unloads the wheel and places it in an upright position for convenient storing. This arrangement is used for handling wheels which are taken out of the pits while they are still so hot that they cannot be rolled.

It remains to be explained how this mechanism is operated. The large ladle *E* is supported on trunnions 6 6, figs. 2 and 3. One of these trunnions has a worm-wheel 7, which is turned by a screw 8 and sheave *Y*, which is operated by an endless chain *W W*, driven by overhead gearing *c*, the movement of which is controlled by a lever *d*. A boy who stands at the lower end of the lever can cause the ladle *E* to oscillate on its trunnions, so as to pour the melted metal into the smaller ladles *J J J*, as they are run one at a time in front of *E*. The trucks *D D D*, which carry the ladles *J J J*, are connected together into a train, as has been explained; to the left-hand end of the train a wire-rope *C C C* is connected, which is carried to the end of the foundry, and then passes over a sheave or pulley 8, and thence up to another pulley 9, and from there to a drum 10, which is driven by suitable gearing, the movement of which can be governed by a lever *e*. The wire-rope is carried around the drum, and from there to other pulleys, similar to 8 and 9, not shown in the engraving, at the other end of the building, and from these it extends, and is attached to the right-hand end of the train of trucks. When the drum 10 revolves it obviously moves the wire-rope *C C C*, and draws the train of trucks either to the right or the left, according to the direction in which either a crossed or a direct belt causes the drum to revolve. The boy at the lower end of the levers can control these belts, and thus move the small ladles up to the large one, and by tipping it can fill them successively, and then transfer them to any of the rows of flasks on the floor. The buggy *N*, fig. 2, is then run over one of the ladles *J J J*, and the bail *g* is attached to it, by which, as has been explained, it can thus be raised and moved horizontally to any of the flasks below the track on which the buggy runs. *K* represents the machinery by which the traveling cranes are operated. *P P* is a wire-rope, one end of which is attached to the buggy *N* at 9, and then passes around the sheave *V* to the drum *U*, and from there to the opposite end of the buggy, to which it is attached at 10. The drum *U* has suitable gearing, which is driven backward or forward by a straight and a cross-belt 11 and 12. These are shifted by means of horizontal wire-ropes *L L*, which run the entire length of the casting floor, and are placed about 5 ft. 6 in. above it, so that a molder or helper can conveniently move the belts from tight to loose pulleys. In this way the buggy *N* can be moved horizontally in either direction by a person standing at any of the flasks in the rows below the traveling cranes. Another wire-rope is fastened stationary at 13, and from there extends to the sheaves 14 on the buggy *N*, down around the sheave *Q*, and up over one of the sheaves 14, thence horizontally to a small sheave 15, and from there to a drum *R*, which

is operated by a worm 16, and suitable gearing that is also driven by a straight and cross-belt 17 and 18. These belts can be shifted by means of another wire-rope stretched alongside and parallel with *L L*. By winding up the wire-rope on the drum *R*, the sheave *Q* and whatever is suspended to it is raised, and by unwinding the rope, the sheave and its load are lowered. It will thus be seen that both the horizontal and vertical movement of *Q* can be controlled by a person at any position below the traveling crane. A boy at the cupola and one of the molders or his helper on the floor can thus move the melted iron from the cupola to the flask without other help.

The double buggy *h*, fig. 4, for handling the wheels to and from the pits is operated by similar machinery, *m*, to that which has been described, and is controlled by a boy by means of levers *n n* and rods *r r*. The boy occupies an elevated platform above the work to be done, where he can have a full view of it, and can direct the movements of the crane and buggy *h* by moving it back or forth, raising or lowering as may be required. The buggy has two sheaves, *k k*, so that two wheels can be handled at the same time. *l* represents a wheel suspended by the crane ready to be lowered or transferred to any other locality.

It is claimed for this plant that a large amount of labor is saved over any other system now in use; that it enables the molders to pour the metal into the flasks much more quickly than is possible if the iron is not handled in this way, and that much more work can be done on a given floor area than by any other system. At the Detroit Car-Wheel Company's foundry they are now casting 425 wheels per day on a floor area of 12,320 square feet, or a little less than 29 square feet per wheel. They are pouring the iron for each wheel in about a quarter of a minute. Three boys and two men distribute all the iron from the cupola, assist in pouring, and pit the wheels. This is all the labor, besides molders and their helpers, which is employed on the casting floor, and with this plant the reduction in cost of labor in making wheel is from 15 to 25 cents per wheel. The system is also in use at the Fort Madison Iron Works at Fort Madison, Ia. There they have 7,000 square feet of floor area and mold 225 wheels per day, or one wheel to a little over 31 square feet of floor area.

NAVAL NOTES.

THREE bids were received for the construction of the armored coast-defense vessel. Cramp & Sons, of Philadelphia, bid $1,614,000; the Union Iron Works, of San Francisco, $1,628,950; N. Palmer & Company, New York, $1,690,000. The contract has not yet been awarded. This vessel, which was described and illustrated in the JOURNAL for February last, pages 78 and 79, is to be of the *Monitor* type, and of 4,000 tons displacement. She will be 250 ft. in length, 59 ft. in breadth, with a mean draft of 14 ft. 6 in. She will be heavily armored, and will carry an exceedingly powerful armament for her size, consisting of one 16 in., one 12 in., and a number of rapid-fire guns, and a 15-in. dynamite gun. The engines are to work up to 5,400 H.P. The plans of the Navy Department provide for two ordinary return tubular marine boilers, capable of supplying steam for 1,500 H.P., the remainder of the power required to be furnished by coil boilers.

The Secretary of the Navy has approved the report of the trial board on the *Yorktown*, pronouncing the vessel all complete with the exception of the electric light plant. The vessel is, therefore, accepted by the Navy Department, subject to a reservation for the completion of the lighting apparatus.

The *Charleston*, which was built in San Francisco by the Union Iron Works, was to have had her sea trial the latter part of April. The *Charleston*, as has been before noted, is a steel cruiser, 300 ft. in length, 46 ft. breadth, 18 ft. 6 in. mean draft, and 3,700 tons displacement. She is intended to make 19 knots an hour at full speed. The guns of the *Charleston* are now on their way to San Francisco, and she will probably be made ready and sent to sea on her first cruise as soon as possible, her services being much needed on account of the loss of the *Trenton* and the *Vandalia* at Samoa.

The Secretary of the Navy has decided that he cannot grant the application of the Columbian Iron Works, of Baltimore, for an extension of time on the gun-boat *Petrel*. The delay in her completion was mainly due to delays in delivery in material, for which the Secretary holds that the Government was not responsible in any way. Under the law he holds that he has no authority to grant the application.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

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[(*Continued from page* 194.)]

CHAPTER XXVI.

THE CARE AND USE OF THE AIR BRAKE.*

QUESTION 688. *How should the brake gear be adjusted?*

Answer. It should be adjusted so that when the brakes are full on the pistons in the brake-cylinders of cars will not have traveled less than 7 in. nor more than 9 in. This will allow for wear of shoes, stretching of rods, springing of brake-beams, etc. Great care must be exercised, when taking up the slack in the brake connections, to have the levers and pistons pushed back to their proper places, and the slack taken up by the pins and holes at the top of the dead levers or in the under connections 23, Plate VI, of the levers.

The driving-wheel brakes should be adjusted so that when they are fully applied the piston will run out not less than 2 in. nor more than 3½ in.

QUESTION 689. *Before leaving the engine house what should the engineer observe?*

Answer. He should know whether the engineer's brake-valve, the air-pump, and the other parts of the brake on the engine and tender are in perfect working order, and if not the defects should be promptly reported.

QUESTION 690. *Before coupling to a train what should the engineer do?*

Answer. He should know that the steam-cylinder of the air-pump was properly lubricated with locomotive cylinder oil, and that the air-cylinder is sparingly lubricated with a small quantity of good mineral lubricating oil. Tallow and lard oils should not be used in the air-cylinders.

The air-pump should be started slowly to allow the water which accumulates in the steam-cylinder, from the condensation of the steam, to escape gradually; it should not be forced out by running the pump with full steam pressure. After the pump has made a few strokes put about a teaspoonful of West Virginia mineral oil into the oil cup of the air-cylinder.

Before coupling to the train, the main reservoirs should be pumped full of air of the maximum pressure of 90 lbs., to insure the release of the brakes on the train, and also to be able to charge the auxiliary reservoirs quickly after the engine is coupled to the train.

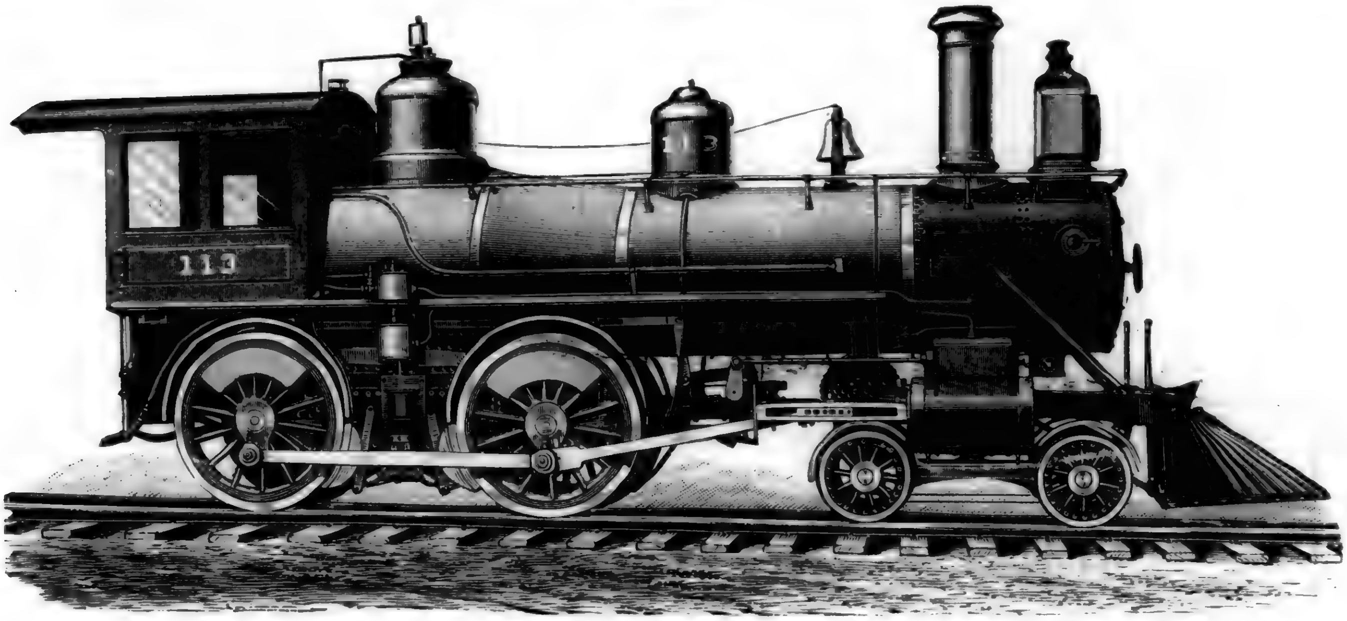
After being connected to the train the handle of the engineer's valve should be turned to the I, or "charging position," until the pressure gauge indicates that the pressure in the train-pipe is equal to 70 lbs. The handle should then be turned to the II position, in order to accumulate an extra pressure of 20 lbs. in the main reservoir.†

The air-gauges which are now supplied for the new automatic brake, as already explained, have two sets of works and two hands—a black and a red one. The black one indicates the pressure in the brake-pipe and the red one that in the main reservoir. The difference of pressure indicated by these hands represents the excess of pressure which is accumulated in the main reservoir over that in the brake-pipe, to aid in releasing the brakes quickly and for recharging the brake-pipe and auxiliary reservoirs. This excess of pressure is accumulated when

* In the answers to the questions in this chapter, free use has been made of the instruction book issued by the Westinghouse Air Brake Company and by some of the railroad companies. The large plate and other illustrations, to which frequent references are made in this chapter, were published in the March and April numbers of the JOURNAL.

† In engraving the large folded plate VI, published in the last number of the JOURNAL, an error was made in numbering the positions of the handle of the engineer's valve 9 in fig. C. The "release position" should have been numbered I, the "running position" II, "closed or on lap" III, "service stop" IV, and "emergency stop" V. By correcting the numbering on the plate, the following description will be made clearer.

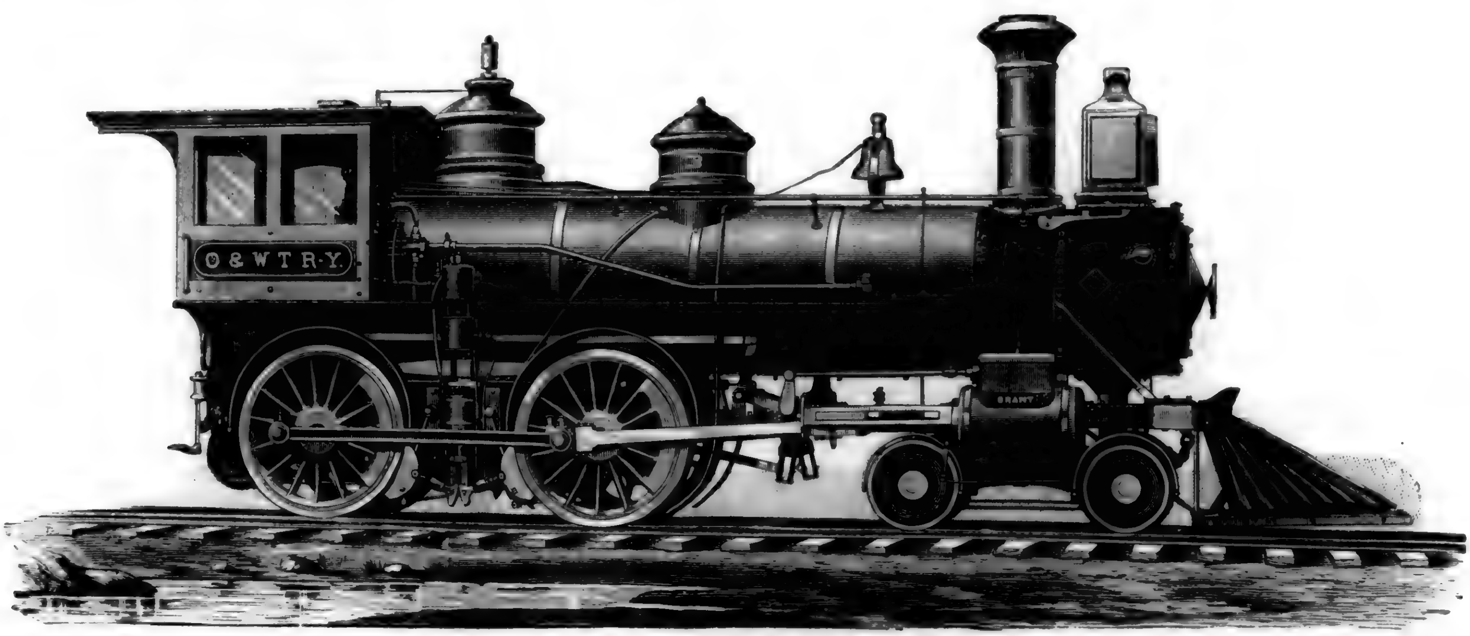
CATECHISM OF THE LOCOMOTIVE.



EIGHT-WHEEL "AMERICAN" LOCOMOTIVE.

BY THE HINKLEY LOCOMOTIVE COMPANY, BOSTON, MASS.

Total weight in working order	96,000 lbs.
Total weight on driving-wheels	64,000 "
Diameter of driving-wheels	5 ft. 2 in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	7⅜ "
Distance from center of front to center of back driving-wheels	8 ft. 6 "
Total wheel-base of engine	23 " 0⅛ "
Total wheel-base of engine and tender	46 " 2¼ "
Diameter of cylinders	17 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler ring	53⅞ "
Length of fire-box, inside	6 ft. 0 in.
Width of fire-box, inside	2 " 11 "
Depth of fire-box, crown-sheet to top of grate	5 " 8 "
Number of tubes	218
Outside diameter of tubes	2 in.
Length of tubes	11 ft. 6 "
Grate surface	17.5 sq. ft.
Heating surface, fire-box	125 " "
Heating surface, tubes	1,230 " "
Heating surface, total	1,355 " "
Exhaust nozzles	Single.
Size of steam-ports	18×1⅛ in.
Size of exhaust-ports	18×2 "
Throw of eccentrics	5 "
Greatest travel of valve	5½ "
Outside lap of valve	0⅞ "
Smallest inside diameter of chimney	1 ft. 2 "
Height, top of rail to top of chimney	14 " 1¾ "
Height, top of rail to center of boiler	6 " 8⅛ "
Water capacity of tender tank	3,000 gals.

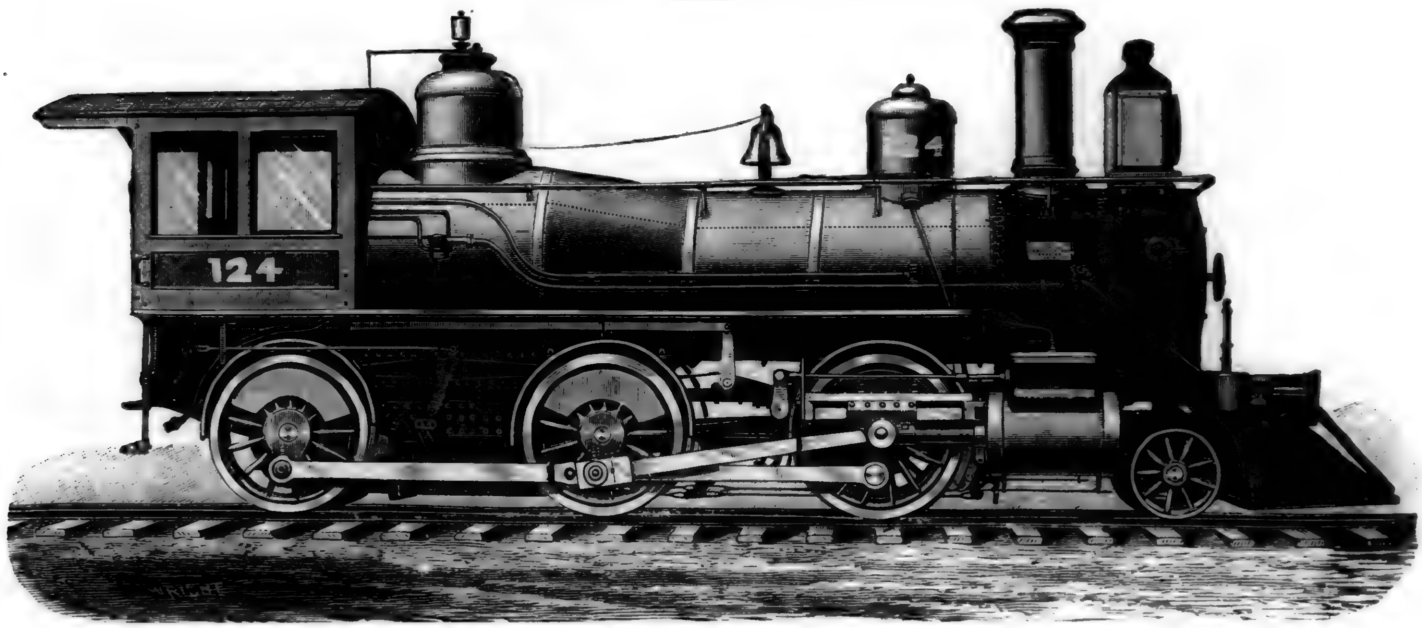


EIGHT-WHEEL "AMERICAN" LOCOMOTIVE

BY THE GRANT LOCOMOTIVE WORKS, PATERSON, N. J.

Total weight in working order	100,000 lbs.
Total weight on driving-wheels	64,100 "
Diameter of driving-wheels	5 ft. 2 in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	7½ "
Distance from center of front to center of back driving-wheels	8 ft. 6 "
Total wheel-base of engine	23 " 3 "
Total wheel-base of engine and tender	45 " 7½ "
Diameter of cylinders	18 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler ring	54 "
Length of fire-box, inside	6 ft. 0 in.
Width of fire-box, inside	2 " 10 3/16 "
Depth of fire-box, crown-sheet to top of grate	5 " 6 "
Number of tubes	227
Outside diameter of tubes	2 in.
Length of tubes	11 ft. 11 "
Grate surface	17 sq. ft.
Heating surface, fire-box	123 " "
Heating surface, tubes	1,343 " "
Heating surface, total	1,466 " "
Exhaust nozzles	Double.
Width of steam-ports	1⅛ in.
Width of exhaust-ports	2½ "
Throw of eccentrics	5⅜ "
Greatest travel of valve	5⅜ "
Outside lap of valve	1 "
Smallest inside diameter of chimney	1 ft. 6 "
Height, top of rail to top of chimney	15 " 0 "
Height, top of rail to center of boiler	6 " 7½ "
Water capacity of tender tank	3,600 gals.

CATECHISM OF THE LOCOMOTIVE.



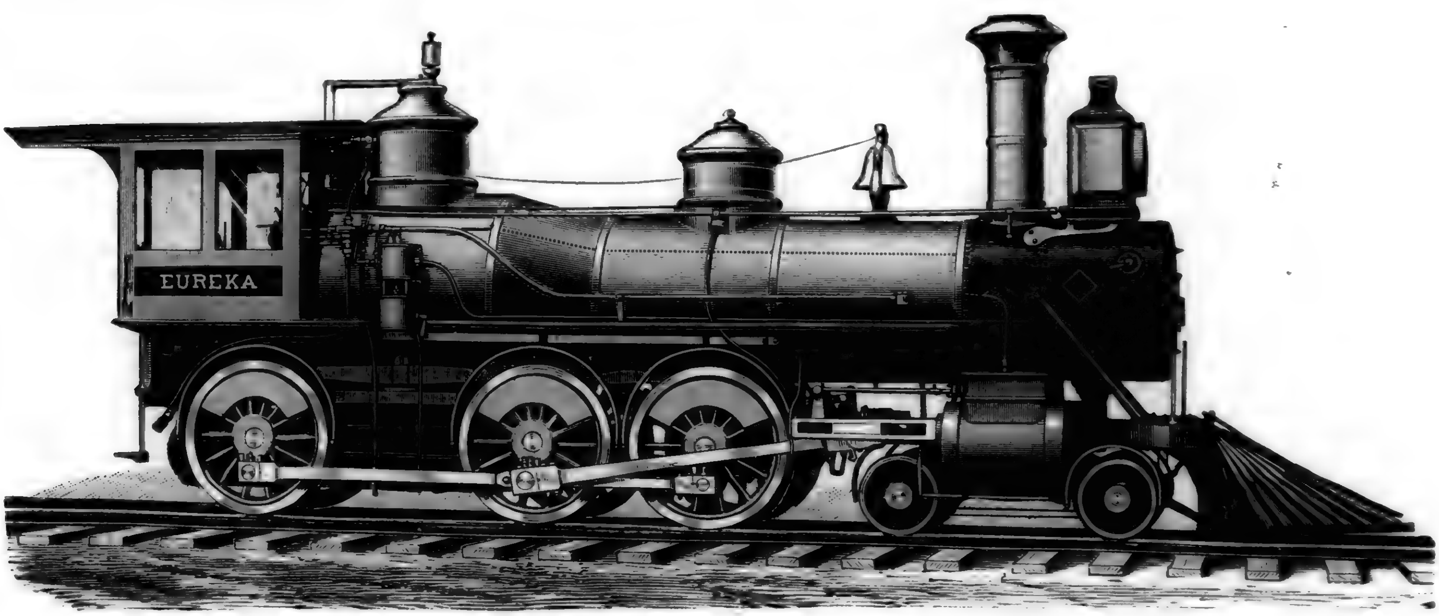
MOGUL FREIGHT LOCOMOTIVE.

BY THE HINKLEY LOCOMOTIVE COMPANY, BOSTON, MASS.

Total weight in working order	104,000 lbs.
Total weight on driving-wheels	90,000 "
Diameter of driving-wheels	4 ft. 4⅛ in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	7½ "
Distance from center of front to center of back driving-wheels	15 ft. 9 "
Total wheel-base of engine	23 " 4 "
Total wheel-base of engine and tender.	46 " 5¾ "
Diameter of cylinders	19 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler ring	53⅞ "

Length of fire-box, inside	6 ft. 0 in.
Width of fire-box, inside	2 " 11 "
Depth of fire-box, crown-sheet to top of grate	5 " 8 "
Number of tubes	218
Outside diameter of tubes	2 in.
Length of tubes	11 ft. 6 "
Grate surface	17.5 sq. ft.
Heating surface, fire-box	125 " "
Heating surface, tubes	1,230 " "
Heating surface, total	1,355 " "

Exhaust nozzles	Single.
Size of steam-ports	18×1⅛ in.
Size of exhaust-ports	18×3 "
Throw of eccentrics	5 "
Greatest travel of valve	5½ "
Outside lap of valve	0⅞ "
Smallest inside diameter of chimney	1 ft. 3 "
Height, top of rail to top of chimney	14 " 0 "
Height, top of rail to center of boiler	6 " 5 "
Water capacity of tender tank	3,000 gals.



TEN-WHEEL FREIGHT LOCOMOTIVE

BY THE GRANT LOCOMOTIVE WORKS, PATERSON, N. J.

Total weight in working order	90,000 lbs.
Total weight on driving-wheels	66,000 "
Diameter of driving-wheels	4 ft. 6 in.
Diameter of truck-wheels	2 " 2 "
Diameter of main driving-axle journal.	7½ "
Distance from center of front to center of back driving-wheels	13 ft. 6 "
Total wheel-base of engine	24 " 6⅛ "
Total wheel-base of engine and tender.	44 " 10⅛ "
Diameter of cylinders	18 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler ring.	52 "

Length of fire-box, inside	6 ft. 0 in.
Width of fire-box, inside	2 " 10½ "
Depth of fire-box, crown-sheet to top of grate	5 " 2⅜ "
Number of tubes	204
Outside diameter of tubes	2 in.
Length of tubes	13 ft. 2¾ "
Grate surface	17 sq. ft.
Heating surface, fire-box	123 " "
Heating surface, tubes	1,359 " "
Heating surface, total	1,482 " "

Exhaust nozzles	Double.
Width of steam-ports	1⅛ in.
Width of exhaust-ports	2½ "
Throw of eccentrics	5½ "
Greatest travel of valve	5½ "
Outside lap of valve	0⅜ "
Smallest inside diameter of chimney	1 ft. 6 "
Height, top of rail to top of chimney	14 " 4⅝ "
Height, top of rail to center of boiler	6 " 1⅛ "
Water capacity of tender tank	3,000 gals.

the handle of the engineer's valve is placed in the II, or running position, and should be about 20 to 25 lbs. As the pressure in the train-pipe should be 70 lbs., that in the main reservoir should be 90 lbs.

QUESTION 691. *In making up trains what should be done?*

Answer. All the hose couplings between the different vehicles should be connected together so that the brakes will be applied throughout the whole train. No brake in any car must be "cut out" unless it is defective. The coupling of the hose at the rear of the last car and at the front of the engine (if there is a hose there) should be attached to the coupling-hook. If for any reason the hose between two vehicles are not used for connecting the brakes they should be attached to their coupling-hooks.

In coupling the hose, place the coupling shoulders, near the stop-pin, firmly together, then twist the heads into place as if they turned on a pivot, firmly pressing the heads toward each other until both heads strike the stop-pins.

All the brake-pipe cocks, 29' 29", Plate VI, should be opened by turning their handles *down or at right angles to the brake-pipe,** excepting that of the cock at the rear end of the train, which should be closed by turning its handle so as to stand parallel with the train-pipe. If the brake-pipe is extended to the front of the engine, the cock at the front end of the train should also be closed. The hose at the front (if there is one at the front) and rear ends of the train should be attached to their coupling-hooks.

The handles *K*, fig. 369, of the four-way cock on the triple-valve of the old brake, and the handles of the cocks under the auxiliary reservoirs should also be turned horizontal.

The new or quick-acting triple-valve has no four-way cock attached to it, but has a stop-cock, *A*, fig. 401, on the pipe which connects the triple-valve with the brake-pipe. This stop-cock should be opened by turning its handle *B* so as to point upward, as shown in fig. 401. When the cock is closed the handle stands horizontal. This same arrangement is used on the new freight car brakes.

It is very important to the successful action of the brake, and to avoid detentions, that the handles of the cocks should be placed in their proper position before starting.

QUESTION 692. *How should the brakes be inspected before starting?*

Answer. Before leaving terminal stations, or wherever there has been any change in the make-up of the train, after all the couplings are made, the engineer should turn the handle of the engineer's valve 9, Plate VI, to the release or charging position (see figs. 371 and 375), and charge the auxiliary reservoirs with air of not exceeding 70 lbs. pressure per square inch. After the reservoirs are charged he should bring the handle to the right, just over the running notch, but not far enough to allow air to escape from the brake-pipe; leaving it in this position for a few moments and observing whether there is any leakage, which will be indicated by a gradual falling off in pressure, as shown by the air-gauge. If there is a leakage it should be found and the defect remedied. The pipes and joints of the brakes must be kept tight, and when leaks are discovered, if the defect is a serious one, the car should not be used until it is repaired.

A person whose duty it shall be to inspect the brakes and *know* that they are in proper order, should then see that all the hand-brakes are released, and then ask the engineer to apply the brakes. The inspector should then walk to the rear of the train, examining the brakes of each car, and see whether they have been applied. If he finds them set all right, he should signal "off brakes" from the rear of the train. The engineer should reply by two light blasts of the whistle or other signal and immediately release the brakes. The inspector should then return to the engine and notice whether the brakes are released on every car. If any are found which are still set, he should release them by turning the handle of the four-way cock *K*, fig. 369, of passenger cars down. When the brakes are released, the handles of the cocks should be turned back to their first position, and the inspector should observe whether there is the full air pressure — 70 lbs.—in the main reservoir. If not, it should be pumped up to full pressure and the brakes applied again by the engineer. If those which were not released on the first test "stick" again, they should first be released by "bleeding" and then cut out. If all the other brakes are released, the brakeman will report all right; if any of them are not released, they should be cut out if they do not release on the second trial.

It should be understood that if cars which have different air pressures in the brake-pipes and auxiliary reservoirs are coupled together, air from the brake-pipe having the higher pressure escapes into the pipe having the lower pressure, and thus applies the brakes on the car which has the greatest pressure. In such cases by "bleeding" the cars, with over-pressure, until the brakes commence to release, the time required to equalize the pressure by pumping on the engine will be saved.

The valves for the application of the brakes from the inside of the car should also be examined when the brakes are inspected, and it should be observed whether all their connections are tight and in good condition.

The discovery of a defect in the brake apparatus affecting its working, either before or during a trip, should at once be made known to all trainmen and to the engineer, so that there may be a proper understanding of it, and measures should be taken to insure safety in running the train.

After making up or adding to a train, or after a change of engines, the rear brakeman should ascertain whether the brake is connected throughout the train. The engineer must, under these circumstances, always test the brakes, to insure their being properly coupled and in order for use.

QUESTION 693. *How should the air pump be worked?*

Answer. While the locomotive is in service it should be run constantly, but not faster than is necessary to maintain the required air pressure in the reservoirs. The pump governor being connected to the train-pipe should constantly be used and should be set to maintain a pressure of 70 lbs. therein, as shown by the air-pressure gauge.

While running the handle of the engineer's valve should be kept in the II, or running position, fig. 371. This allows the brake-pipe and auxiliary reservoirs to be charged with air and an excess of pressure to be accumulated in the main reservoir.

QUESTION 694. *How should the brakes be applied to make ordinary stops?*

Answer. The brakes, as has been explained, are applied when the pressure in the brake-pipe is suddenly reduced, and released when the pressure is restored.

It is of very great importance that every engineer should bear in mind that the air pressure may sometimes reduce slowly, owing to the steam pressure getting low, or from the stopping of the pump, or from a leakage in some of the pipes when one or more cars are detached for switching purposes, and that in consequence it has been found absolutely necessary to provide each cylinder with what is called a leakage groove, which permits a slight pressure to escape without moving the piston, thus preventing the application of the brakes when the pressure is slowly reduced, as would result from any of the above causes.

This provision against the accidental application of the brakes must be taken into consideration, or else it will sometimes happen that all of the brakes will not be applied when such is the intention, simply because the air has been discharged so slowly from the brake-pipe that it only represents a considerable leakage, and thus allows the air under some cars to be wasted.

It is thus very essential to discharge enough air in the first instance, and with sufficient rapidity, to cause all of the leakage grooves to be closed, which will remain closed until the brakes have been released. In no case should the reduction in the brake-pipe for closing the leakage grooves be less than 4 or 5 lbs., which will move all pistons out so that the brake-shoes will be only slightly bearing against the wheels. After this first reduction the pressure can be reduced to suit the circumstances.

On the other hand, locomotive runners should be careful not to use too much force in making ordinary stops. By applying the brakes at a fair distance from the station, with moderate force, the train may be stopped gently and without inconvenience to the passengers, while if the brakes are put on with too much force, the train is jerked in a manner that is extremely disagreeable, and may be dangerous to the passengers. To avoid this in making a stop, the handle of the engineer's valve should not be turned beyond the IV position; "for service stops," see fig. 371. With a train of two or three cars the handle should be kept in that position for a few seconds only and should then be closed gently by moving the handle to the III position, when the pressure in the brake-pipe has been reduced from 4 to 8 lbs. as indicated by the gauge. The brakes are fully applied when the pressure in the brake-pipe, as shown by the gauge, has been reduced about 20 lbs. *Any further reduction is a waste of air.* The brakes should be applied far enough away from the station so that the train may be controlled and stopped without moving the handle beyond the IV position. As the brakes on the train are applied from the auxiliary reservoirs, frequent use of the brakes reduces the pressure, and consequently the power of the brakes; for while applying the brakes the supply of air to the reservoirs through the brake-pipe is cut off. Therefore, after each application the handle of the engineer's valve should be turned to the extreme left until the maximum pressure is obtained, after which it should be moved to the II position, where it should remain while running. It is bad practice to apply and release the brakes more than once or twice at the most in service stops, unless time is given between application for recharging

* On the old brake the plugs of these cocks are horizontal, on the new quick-acting brake they stand vertical.

the train reservoirs, as it reduces the pressure too much on the train.

The most satisfactory stops are made by applying the brakes, lightly at first, at sufficient distance away, and increasing the pressure as the train draws nearer the station until it is almost stopped; then, excepting on heavy grades, releasing the brake, by turning the handle to the I position, to avoid jerking the train. After the air has been released from the brake-pipe of long trains, by placing the handle of the brake-valve in the IV, or "service stop" position, and is then moved back to the III, or "closed" position, air will continue to escape through the valve, as explained in answer to question 647, until the pressure has been reduced uniformly throughout the brake-pipe by an amount indicated by the black pointer of the gauge. This is the equalizing feature of this valve which is of great importance in the operation of the brakes, especially on long trains.

A reduction of pressure in train-pipe of about

7	lbs.	will	give	about	4	lbs.	per sq. in.	in brake-cylinder.
9	"	"	"	"	19	"	" "	"
11	"	"	"	"	26	"	" "	"
13	"	"	"	"	40	"	" "	"
15	"	"	"	"	46	"	" "	"
17	"	"	"	"	50	"	" "	"

QUESTION 695. *How should the air-brake be used in case of danger?*

Answer. In case of danger the object, of course, is to stop as quickly as possible without reference to the comfort of any one. In such cases the handle of the engineer's valve should be turned to the V, or "emergency position." Stops should not be made in this way any oftener than is necessary, as they are liable to slide and flatten wheels of the train.

QUESTION 696. *What must be done to release the brakes?*

Answer. The handle of the engineer's valve must be turned to the extreme left, or to the I, or "release position," quite against the stop, and should be kept there for about 10 seconds and then moved back to the II position against the intermediate stop, which is the feed position, and is where it should remain while the train is running. This course is necessary so as to be always ready with an excess of pressure in the main reservoir to release the brakes and avoid the necessity of "bleeding" to release them. The handle should never be left midway between these two positions, as this will nearly, if not quite, close the passage leading to the brake-pipe.

If the air-gauge, while running, shows too much excess of pressure, the excess pressure-valve 21, fig. 373, may have become obstructed. After coming to a full stop at a station, move the valve-handle to the "emergency position," V, and accumulate a high pressure in the main reservoir; then move the handle back from the "emergency position," V, to the "running position," II, so that the full reservoir pressure is brought upon the excess pressure-valve, to blow out any obstruction. If the difficulty is thus removed, the black hand of the gauge should move up to within 20 lbs. of the red one; if it does not, the valve should be examined and cleaned.

Where two or more engines are coupled in the same train the cock 8, fig. B, Plate VI, should be closed upon all but the head engine of the train, in order to permit this engine to handle the train brakes without interference from the other engines.

Engineers of all trains should avoid making exhibition stops, and should never, excepting on a heavy grade, or in case of necessity, hold the brakes fully applied until the train comes to a full stop, as this causes a reaction in the motion of the train which is very disagreeable to passengers, and in case of a long freight or stock train, is damaging when there is much slack in the couplings. This can be avoided ordinarily, on passenger trains, as already explained, by releasing the brakes gradually before coming to a full stop, so that all the air will be off at the moment the stop is made.

On a long train, if the engineer's brake-valve be opened suddenly and then quickly closed, the pressure in the brake-pipe, as indicated by the gauge, will be suddenly and considerably reduced on the engine, and will then be increased by the air pressure coming from the rear of the train; hence it is important to always close the engineer's brake-valve slowly and in such a manner that the pressure, as indicated by the gauge, will not be increased, or else the brakes on the engine and tender, and sometimes on the first one or two cars, will come off when they should remain on.

On long down grades it is important to be able to control the speed of the train, and at the same time to maintain good working pressure. This is easily accomplished by running the pump at a good speed, so that the main reservoir will accumulate a high pressure while the brakes are on. When after using the brakes some time, the pressure has been reduced to 60 lbs., the train-pipes and reservoirs should be recharged as much as possible before the speed has increased to the maximum allowed. A greater time for recharging is obtained by considerably reducing the speed of the train just before recharging and by taking advantage of the variation of the grades.

To release the brakes with certainty, it is important to have a higher pressure in the main reservoir than in the main pipe. If the engineer feels that some of the brakes are not off, it is best to turn the handle of the engineer's brake-valve just far enough to shut off the main reservoir, and then pump up 15 or 20 lbs. extra, which will help to release the brakes, all of which can be done while the train is in motion.

QUESTION 697. *If, while the train is moving, the brakes are applied from some cause unknown to the engineer, what should he do?*

Answer. Whenever the brakes are applied from any cause, it is important to maintain an excess of pressure in the main reservoir, in order to be able to release them promptly thereafter. If there is but a slight reduction of pressure in the train-pipes, indicating that the brakes have been applied by leakage, he should at once move the handle of the brake-valve to the I position in order to release them; but if the brakes should be applied at once and the air-gauge show that all the air in the train-pipe has escaped, he will know that a pipe or hose has burst, a coupling has been broken, or that a conductor's valve has been opened, and he should aid in stopping the train by turning the handle to the V, or "emergency position," to stop as quickly as possible, and also to prevent the escape of air from the main reservoir. When the train is stopped he can release the brakes and await the signal from the conductor to proceed. If the brakes are not released by turning the handle to the I, or "release" position, it should be put on the III, or "closed" position, until the pressure in the main reservoir has been increased 10 or 15 lbs., and the handle should then be turned to the I, or "release" position. If this does not accomplish the desired end, the brakes should first be applied quickly and then released. If the engineer is not able to release the brakes, he should signal the fact to the trainmen, who will then assist in releasing them by "bleeding."

QUESTION 698. *How are the brakes applied from the inside of the cars?*

Answer. This can be done in three different ways: *First*, by opening the conductor's valve, by pulling on its cord and *holding it down* until the train is stopped. The new form of conductor's valve has no spring, and is open when the handle is up, and will remain so without holding it. *Second*, by disconnecting the hose couplings. *Third*, by opening the cock 29", Plate VI, on the brake-pipe on the rear end of the train. These methods should be used only in cases of emergency.

QUESTION 699 *In running trains up or down steep grades exceeding 100 ft. per mile and a half mile in length what should be observed?*

Answer. The engineer should assure himself that the brake apparatus is in good working condition. Before going down such grades he should examine the valve-gear carefully, to see that it will be efficient if the engine is reversed.

QUESTION 700. *Why is the train-pipe carried to the front end of the locomotive?*

Answer. This is done so that the brakes on the locomotive can be coupled together, in case two locomotives are used on the front of the same train—called a "double-header"—or so that the brakes of the locomotive can be coupled to the cars, in case it is used as a pusher at the rear end of a train.

QUESTION 701. *How are the air-brakes operated on a "double-header," or when two engines are coupled together?*

Answer. When two or more engines equipped with air-brakes are coupled to a train, *the forward engine should control the air brake*, but all the engines should be connected to the brake-pipe. When the train is in motion, the stop-cock 8, fig. B, Plate VI, should be closed upon all but the leading engine, and the leading engineer should do all the braking. Otherwise the brakes may all be pumped off, by the rear engineer, very soon after the brakes are applied by the first engineer, and this will render the brakes useless. Hence the leading engine must control the train brakes entirely and absolutely, except in case of accident to the air of leading engine, and until a proper signal is given by the first engineer for the second engineer to assume control of the air-brakes on train, for which contingency the second engineer must at every moment be *prepared to act instantly on a mountain grade.*

If from any cause the supply of air or any part of the brake on the leading engine has failed, and it is desired to give up the control of the brakes to the second engineer, a signal (usually two short and one long blast of the whistle — — ———) should be given by the first engineer, and the second one by repeating it should signify that he understands it and has control of the air-brakes. The second engineer having assumed control of the brakes, should retain entire charge of them to the end of the trip, unless it may be necessary to again put them in charge of

the first one. On heavy grades the aim of the engineer should always be *to keep control of the train. Descending at high speed must not be practiced with any train*, for there may come a time when some part of the machinery may fail, and *while it may be practicable to control speed by hand-brakes at* 8 *to* 10 *miles per hour, it may be impossible at* 20 *to* 30 *miles per hour to regain its control.**

The driver-brakes should not be used too freely on mountain grades, as it heats the tires of driving-wheels, expands and loosens them on the wheel centers, which may not only destroy their brake efficiency, but may make the engine useless for draft purposes also.

QUESTION 702. *How can the brakes be released if they are applied on a car which is not coupled to an engine, or if from other cause they cannot be released by the locomotive runner?*

Answer. On passenger cars this is done by turning down the handle of the release cock, 20, Plate VI—below the auxiliary reservoir—which opens it and allows the air in the reservoir to escape; which—in railroad parlance—"bleeds" the reservoir and the brake-cylinder.

QUESTION 703. *How can the brakes be released when they have been applied by a burst hose?*

Answer. By closing the brake-pipe cock directly in front of the burst hose; the brakes ahead of it can then be released by the locomotive runner, and those behind it, as has been described in answer to the previous question.

QUESTION 704. *What is meant by "cutting out" the brakes on a car?*

Answer. It means that the compressed air in the brake-pipe is shut off from the triple-valve, auxiliary reservoir, and brake-cylinder, so that they do not operate, but the air can still pass through the brake-pipe to the cars behind.

QUESTION 705. *How can the brakes on a car be cut out?*

Answer. With the old form of automatic brake the handle *K*, fig. 369, of the four-way cock attached to the triple-valve should be turned down to the half-way position II, fig. *A*, Plate VI, and the release cock 20", below the auxiliary reservoir, should be opened, so as to release the brakes on the car if they are on.

QUESTION 706. *What must be done if a car or the engine is detached from the train?*

Answer. When any of the vehicles in a train must be uncoupled, trainmen should not close the brake-pipe cocks, by turning their handles at right angles to the brake pipe, or disconnect the hose until the brakes have first been released by the engineer. Before engines or cars are uncoupled, the brakes should be fully released on the whole train. Neglecting this precaution, or setting the brakes by opening a valve or cock when the engine is detached, may cause serious inconvenience in switching.

The cocks 29' 29", Plate VI, on each side of the hose couplings to be separated should then be closed—by turning their handles at right angles to the brake-pipe—to prevent the application of the brakes on the cars which are uncoupled. The hose couplings should then be disconnected. *This must always be done by hand*, and the couplings should then be hung on their coupling-hooks.

QUESTION 707. *What is essential in taking care of the brake-cylinders and other parts of the brakes?*

Answer. The brake-cylinders must always be kept clean and free from gum, so that they will readily release when the air has been discharged, and should be oiled once in three months with suitable oil furnished for that purpose. The last date of oiling should be marked on the cylinders with chalk. The pistons should be taken out once a year and cleaned, at which time the brake rigging should have a general overhauling and be tested. The date of this general overhauling and testing should be stencilled in white lead on the cylinder.

All parts of the brakes should be kept clean and in good condition, and the pipe connections tight.

QUESTION 708. *How should the air-pumps be taken care of?*

Answer. The steam-cylinder should be lubricated with a small quantity of engine oil, and the air-cylinder should be sparingly lubricated with a small quantity of 32° gravity West Virginia mineral oil (tallow or lard oil should not be used in the air-cylinder).

In case the air-pump gets hot in operation on the road, use a small amount of valve oil, *not tallow*, to overcome the difficulty temporarily. Head-light oils will cut the gum out, but except it is very thoroughly cleaned out will cause heating worse than before, and is bad oil to use on this account.

The best means for cleaning out the air-pump thoroughly, and it should be done at the shops, is to disconnect the discharge pipe and pump through a few quarts of weak lye, discharging it into a proper vessel and pumping it through again until all passages are thoroughly cleaned. After the lye use clean warm water, to thoroughly clean out all the passages, then remove the lower head, shove the piston to the upper head, and oil the cylinder bore with oily waste.

QUESTION 709. *How should the triple-valves be taken care of?*

Answer. In cold or damp weather they should be drained frequently to let out any water that may have collected. This can be done by slacking the nut or the plug in the bottom of the triple-valve, and thus letting the water escape; the plug should then be screwed up again. The water in the drain-cup on the tender should be drained out daily in cold or damp weather by the cock under it. The valves for the application of the brakes from the inside of the car should be kept tight.

QUESTION 710. *What should be observed with reference to the main reservoir?*

Answer. The water should be drained out of it ordinarily once a week, and in winter or damp weather daily. If the pump is not kept well packed considerable water will accumulate in the main reservoir.

QUESTION 711. *What should be done in case a train breaks in two?*

Answer. In case a train breaks in two the *brakeman should close the stop-cock on the rear car* of the part of the train remaining attached to the engine, when he reaches it, and then give the engineer a signal to let the brakes off.

When cars are again properly coupled up, *before opening the air into the rear end of the train*, the brakeman should give the engineer a signal to set the brakes, which should be done strong, and be left on until the brakeman opens the air-cocks into rear section of the train. When this is done the engineer will have regained control of the air in the entire train as before the break in two.

This action will save valuable time, which otherwise may be spent in releasing the air on each car by hand.

QUESTION 712. *What should be done in case hose couplings are frozen, so that they cannot be uncoupled, or leak?*

Answer. They should be thawed with a lighted torch, care being taken so as not to heat them so hot as to injure the packing or rubber of which the hose is made.

QUESTION 713. *How does the Automatic Freight Train Brake operate?*

Answer. The construction and operation of the freight train brake is substantially the same as that of the passenger train brake. The parts of the freight brake are, however, lighter and are arranged more compactly. They are shown in figs. 387–392.

QUESTION 714. *When and how is the pressure-retaining valve used on freight cars?*

Answer. As explained in answer to question 665. In going down long grades it becomes necessary for the engineer to recharge the reservoirs with air, and to do so he is obliged to release the brakes. When the handle of the pressure-retaining valve 40, fig. 387, which is located at the end of the car near the brake-wheel, is turned horizontal, an air pressure of 15 lbs. is retained in the brake-cylinder after the brake is released by the engineer. When the valve-handle points down, the valve allows the air to exhaust freely from the brake-cylinder when the brakes are released.

The retaining feature of this valve should only be used on long grades; at all other times the valve-handles should be turned to point down.

QUESTION 715. *What precaution should be taken in cases when only a part of the cars, or the engine and tender only are equipped with air-brakes?*

Answer. After shutting off steam from the engine, engineers should allow the slack of the train to close in against the engine before applying the brakes. This, to a great extent, will prevent concussions of cars against each other in the rear portion of the train, which are not provided with air-brakes.

(TO BE CONTINUED.)

* From the Code of Rules Governing Engineers and other Employés in use of Westinghouse Air-Brakes on the Northern Pacific Railroad.

Manufactures.

Cars.

THE United States Rolling Stock Company has taken a contract for 1,000 freight cars for the Central Railroad of Georgia, which will be built at its shops at Anniston, Ala. The Company has also a contract for 200 freight cars for the Savannah, Florida & Western road.

THE Raleigh & Gaston Railroad Company is building three new passenger cars in its shops in Raleigh, N. C.

The "Continuous" Rail-joint.

THE accompanying illustrations show a new rail-joint which is now being introduced after careful preliminary trials.

This joint is made up of two parts: one the splice-bars, which are used to maintain line, and the other the clamp, which is provided to maintain surface.

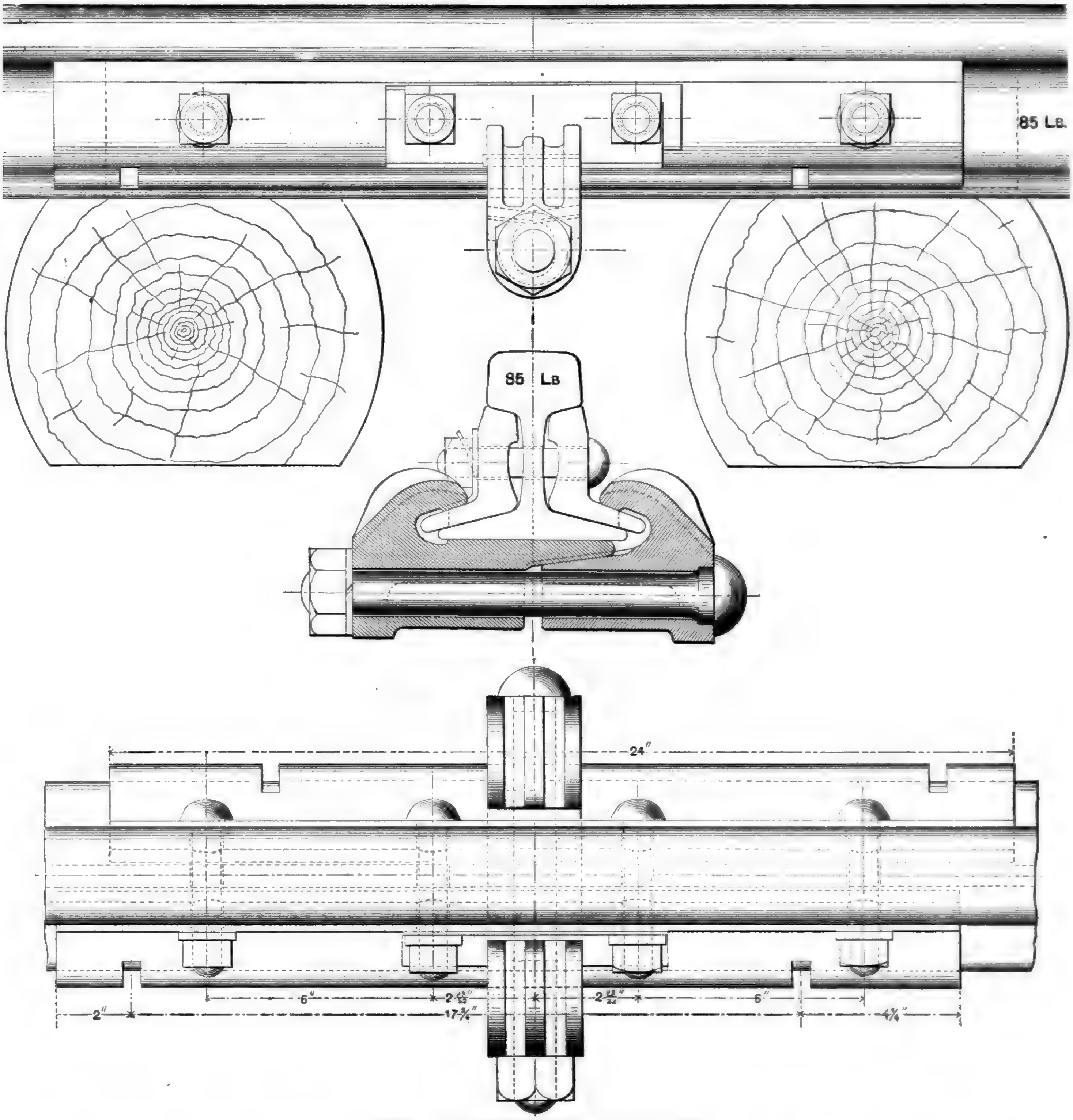
The splice-bars used have their bearing in the usual way, between the under side of the head of the rail and the top side of the rail base, but with the outer edges of the bars formed so as to reach beyond the base of the rail, but not to bear upon or touch the supporting ties.

The clamping device is so constructed that it engages the angle-bars within the line of the rail base, maintaining the two connecting rails rigidly together in the same plane or surface, allowing no vertical motion. These two devices co-acting ensure an even wear of rail from end to end. This makes the device a self-contained and structural one; making the joint as nearly equivalent as possible to the unbroken rail. The conditions for the support of it are only those demanded for the main body of the rail.

The bars are slotted so as to allow of the usual spiking to prevent the creep of rails, except that the spikes have a bearing against the edge of the rail.

Experimental sections of track laid with this joint have been in use on five or six railroads for from 12 to 18 months. On one piece of track they have withstood a service of over 20,000,000 tons passing over them, the daily average being 1,740 cars; and in that time the joint ties required but one surfacing and the nuts but one going over to tighten.

This joint, it is claimed, will correct the uneven wear at the ends of the rails, if not battered. It is also claimed that the joint is no longer an experiment, but that its utility has been demonstrated.



THE "CONTINUOUS" RAIL-JOINT.

The manufacturers make the following claims for it:

1. Strength of joint equal to that of the body of the rail.
2. Increased endurance of rail.
3. Economy in maintenance of joints and ties thereunder.
4. Smoothness of track, ensuring easy and quiet riding.
5. Reduction in first cost over all six bolt splices.

All of these claims are made after trials extending over a period of 18 months, as noted above.

The "continuous" rail-joint is manufactured by the McConway & Torley Company, of Pittsburgh, Pa.

The Robert Steel Process.

In view of the interest felt in new processes in the manufacture of steel, we give herewith the illustrations and the greater part of the specifications of patent No. 400,010, dated March 19, 1889, and granted to Gustave L. Robert, of Stenay, France (Assignor to John W. Bookwalter, of Springfield, O.), for a "process of converting crude iron into malleable iron or steel."

Mr. Robert claims that his invention overcomes the defects inherent in the rapid mode of conversion of iron into steel, by providing means for maintaining constant relations throughout the whole period of conversion, this being effected by varying the position and volume of the blast.

In the accompanying illustrations, figs. 1, 2 and 3 show the operation and conditions at three different stages in the process, which is thus described by the Inventor:

Fig. 1.

Fig. 2.

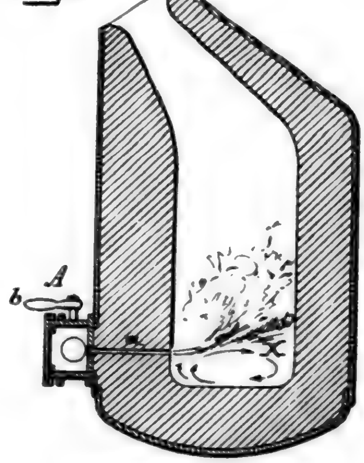
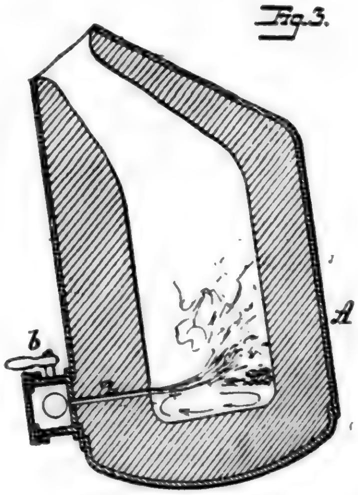


Fig. 3.



"The mass of metal constituting the bath *X* is passed in a molten form into the converter *A*, as usual. The latter is tilted so as to carry the surface of the metal to the tuyeres *a*, as shown in fig. 1, that the converting-blast may be thrown upon the surface of the metal.

"In order to vary the volume and pressure of the blast for the purpose described, I throttle the passage through which the air is conducted to the tuyeres in any suitable manner—as, for instance, by an ordinary valve controlled in its position by a handle, *b*—and while different means may be employed for varying the height of the blast in respect to the normal surface of the metal, I prefer to effect this result by tilting the converter to different positions during different stages of the operations. Thus, at the beginning of the operation, the converter is tilted so that the blast, which is then at its maximum pressure, is applied upon the surface in such manner as will overcome as speedily as possible the inertia of the metal and quickly impart to it the desired speed of gyration.

"In applying the blast in the beginning of the operation it is projected at such an angle as to come into contact with a more extended surface of the metal than at subsequent stages of the operation for the purpose of avoiding the overoxidation that would result from applying the blast violently and in large volume upon a limited area of the metal. After the metal has acquired the desired speed of gyratory motion, the converter is tilted to lower the bath to its position (shown in fig. 2), so as to act upon a more limited area of the metal at one time, but with a greater atomizing or dividing effect, bringing the particles of iron into more intimate contact with the air and increasing the combustion and heat and the fluidity of the metal, and with this change in the position of the blast I begin to reduce the volume and the pressure, proportioning such reduction to the effect desired to be produced, as may be determined by indications easily recognized by any one skilled in the operation of conversion. As the process continues, the converter is further tilted toward the position shown in fig. 3, and from this on the pressure and position of the blast are so varied or maintained as may be necessary to secure the desired result.

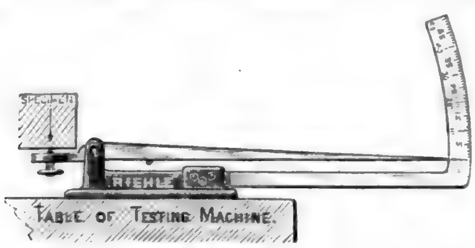
"By the operation above described, I can readily avoid the tendency to overoxidation that results at the beginning of the rapid process of conversion from the inertia of the metal, the sluggishness of its movements, and from the difficulty of imparting to it the desired speed of gyration by a blast applied locally at the surface, without also supplying an excess of the oxidizing agent."

The claims in the patent specifications are as follows:

"1. The within-described improvement in the conversion of crude iron into malleable iron or steel, consisting in applying a blast of air to the surface portion of a body of molten metal at a maximum pressure at the beginning of the operation for the purpose of overcoming the inertia of the metal and imparting thereto the proper speed of gyratory motion, lowering the level of the blast as the process continues without carrying it into the body of the metal, and varying the pressure and volume of the blast to meet the requirements of the reduction in the combustible elements of the iron and the increased fluidity of the metal, substantially as set forth.

"2. In the process of converting crude iron into malleable iron or steel by the action of a blast applied locally upon the surface of the mass of molten metal, varying the level of the blast and the volume and pressure thereof in proportion as the metal increases in speed of gyration and fluidity and as the combustible elements are eliminated, substantially as set forth."

Adjustable Transverse Elastic Limit Indicator.



The illustration herewith shows the Riehle adjustable transverse elastic limit indicator.

This apparatus can be placed on the lower table of any testing machine, and when the transverse specimen is in position it is placed underneath the center of the specimen, and adjusted with the pointer on the zero mark. As the test proceeds the pointer will pass over the face of the scale, and show in thousandths of an inch the deflection that the specimen is being subjected to. This is an ingenious device, and its importance to those investigating these things is apparent.

An apparatus of this kind can be made, and is made, in several sizes, suited to the larger machines, and for the smallest machines. The one shown in the illustration was made for the Dennis Long Company, and is used in testing the elasticity of cast-iron specimens.

This apparatus is made by Riehle Brothers, the well-known manufacturers of scales and testing machines, Philadelphia.

Locomotives.

The Pittsburgh Locomotive Works recently completed several freight engines for the St. Louis, Vandalia & Terre Haute Railroad, and have a number of orders on hand.

The Baldwin Locomotive Works, Philadelphia, recently delivered three passenger engines to the Raleigh & Augusta Air Line. Late orders include 10 passenger engines for the Philadelphia & Reading Railroad.

The Rogers Locomotive Works, Paterson, N. J., are building a number of consolidation engines for the Louisville & Nashville road.

The Schenectady Locomotive Works, Schenectady, N. Y., are building three passenger engines, with 18 by 24 in. cylinders,

15 mogul freight engines, and seven six-wheel switching engines, for the Lake Shore & Michigan Southern road.

THE Brooks Locomotive Works, Dunkirk, N. Y., are building six engines for the Kansas City & Southern road.

THE Rhode Island Locomotive Works, Providence, recently delivered 10 locomotives to the Savannah, Florida & Western; five to the Charleston & Savannah, and seven to the Brunswick & Western.

The Non-Pressure Car Heater.

THE accompanying illustration shows the construction and general arrangement in the car of a heater, which has been tested for some time in general use and is now being introduced for this special purpose. It belongs to the class in which hot water is the heating agent; this water circulates through the coils, receiving its heat in the first place ordinarily from steam brought from the locomotive, but in case of necessity from a fire built in the heater itself.

The form of this heater, both internally and externally, is very simple. The steam supply pipe *E* is carried down through the vertical flow-pipe, on top of the heater, into a steam-heating drum, *D*, which is provided with a waste-pipe, *F*, to carry off any condensed water through the lower circulating pipe *B*. These pipes and fittings are made abundantly heavy; the drum *D* is of steel tested to 500 lbs. The steam-pipe is 0½ in. in diameter.

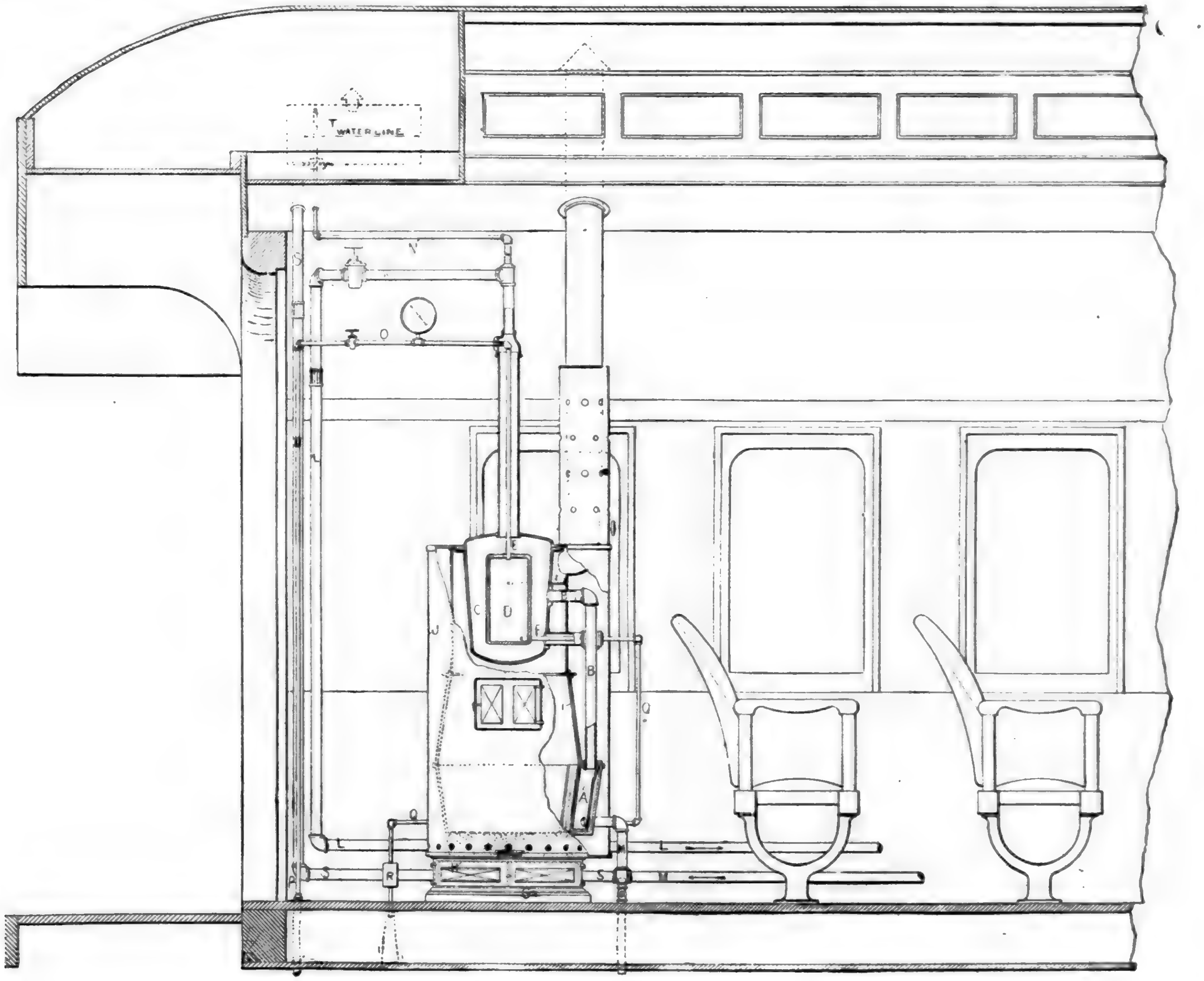
The steam drum is 12 in. high by 6 in. in diameter, and with that portion of the steam-pipe which passes through the flow-pipe, gives a total of about 2½ square feet of heating surface.

The heater *C* is connected by the pipes *B B* with the water-back *A*, which serves as the heater when fire is used. This water-back is one-fourth of the circumference of the fire-pot.

One of the circulating pipes, *B B*, enters the circulating vessel *C* at a higher level than the other. The circulating vessel is fitted on top with the 2½-in. flow-pipe. The vessel is 12 in. in diameter and 18 in. high, having a conical or tapered form, made of steel and subjected, with the water-back and circulating pipes, to an hydraulic test of 300 lbs. per square inch.

These circulating parts, furnished with the steam-heating drum *D*, supply pipe *E*, and waste pipe *F*, are fitted to a cylindrical cast-iron frame, *I*, fig. 2, with semi-circular deflecting plate I_1 around water circulating vessel *C*. This plate I_1 is to prevent the gases of combustion passing directly from the combustion chamber to the chimney and to cause them to pass around the circulating vessel before escaping.

An opening in the casting above the fire-pot is fitted with a door having a suitable fastener; through this the fuel is supplied to the fire. The fire-pot is of cast iron; one-fourth of its circumference being formed by the water-back *A*, it is shaped to hold a large supply of fuel.



When fire is used the heater may be operated as an ordinary stove, requiring little or no more attention. The base is, of course, made so as to be properly fastened to the floor of the car, and the whole heater is covered with a sheet-iron case, which encloses the heater itself, circulating pipes, etc.

The supply of water is kept up from the tank *T*, which communicates through the pipe *N* with the flow-pipe. The waste of water is, however, very small, and the tank does not require much watching.

In a car provided with this heater the flow in the pipes may be controlled and stopped without any increase of pressure, and the heating surface can therefore be divided into sections, so that more or less radiating surface may be used, if desired; in this way in a drawing-room or sleeping-car divided into sections, the heat can be shut off from any part of the car as from a room in a house, giving an opportunity to regulate the heat as desired without affecting the temperature of the rest of the car. The makers claim the further advantage that hot water for washing, etc., may be taken off from the pipes wherever needed by simply putting in a valve at the proper point. In this way a supply of warm water for wash-basins in the car may be ob-

tained by simply increasing the size of the supply tank. There is a further great advantage in the absence of pressure in the pipes.

This heater will circulate and transmit heat through any system of pipes, and it may be applied to the pipes of the storage system by the addition of a return pipe.

The general dimensions of the heater are: Diameter of grate, 13 in.; diameter of fire-pot, 19 in.; height of fire pot, 14 in.; diameter of smoke-pipe, 5 in.; width of heater over smoke-pipe connection, 25 in.; diameter of casing, 22 in.; size of base, 22 in. by 22 in. square; height of heater, 50 in.: approximate weight, 400 lbs. It is made by the Non-Pressure Heater Company, of New York.

Bridges.

THE Atlanta Bridge Works, Atlanta, Ga., are building an iron bridge over the Chattahoochee River, near Columbia, Ala., for the Central Railroad of Georgia. This bridge has a draw span 230 ft. long, and one fixed span of 100 ft.

THE Phœnix Bridge Company, Phœnixville, Pa., has completed an iron bridge over New River at Riverview, W. Va., on the Chesapeake & Ohio road, having one span 200 ft.; one 250 ft., and one 300 ft. in length.

THE Penn Bridge Company, Beaver Falls, Pa., has just finished a new iron drawbridge over Grand River, near Painesville, O.

THE Passaic Rolling Mill Company, Paterson, N. J., is building several bridges for the Chesapeake & Ohio Railroad.

Manufacturing Notes.

THE firm of Robert Poole & Son, of Baltimore, has been reorganized as the Robert Poole & Son Company, the officers being Robert Poole, President and Treasurer; George Poole, Vice-President and General Manager; Millard S. Black, Secretary.

THE Prentiss Tool & Supply Company removes its office on May 1 to 115 Dey Street, New York. From that date the Company will act as agent for the Putnam Tool Company, of Fitchburg, Mass.

THE Johnson Railroad Signal Company is enlarging its Works at Rahway, N. J., to meet the demands of increasing business.

E. F. GARVIN & COMPANY have removed their machine shops and offices to the new building corner Laight and Canal Streets, New York.

THE Bucyrus Foundry & Manufacturing Company, Bucyrus, O., is running its works extra time to fill orders, business being very active.

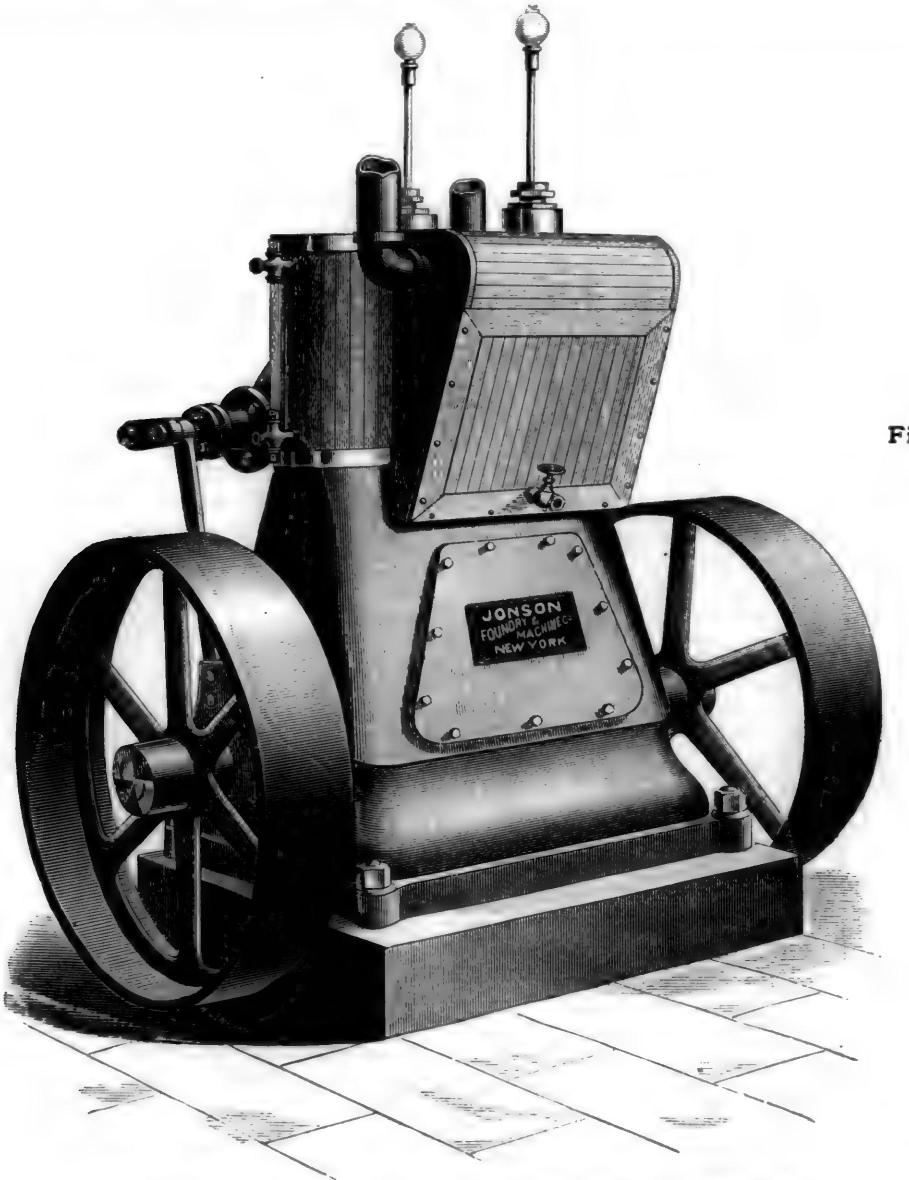


Fig. 1.

JONSON'S PATENT BALANCED COMPOUND ENGINE.

Blast Furnaces of the United States.

THE *American Manufacturers'* monthly statement gives the condition of the blast furnaces on April 1, as below: "The condensed statement is as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	63	12,150	103	11,751
Anthracite	100	33,267	96	24,592
Bituminous	161	106,267	84	42,398
Total	324	151,684	283	78,741

"The table shows an increase of 13 furnaces in blast on April 1, as compared with the number in blast March 1. There has been an increase of 4 in the number of charcoal, 9 in the num-

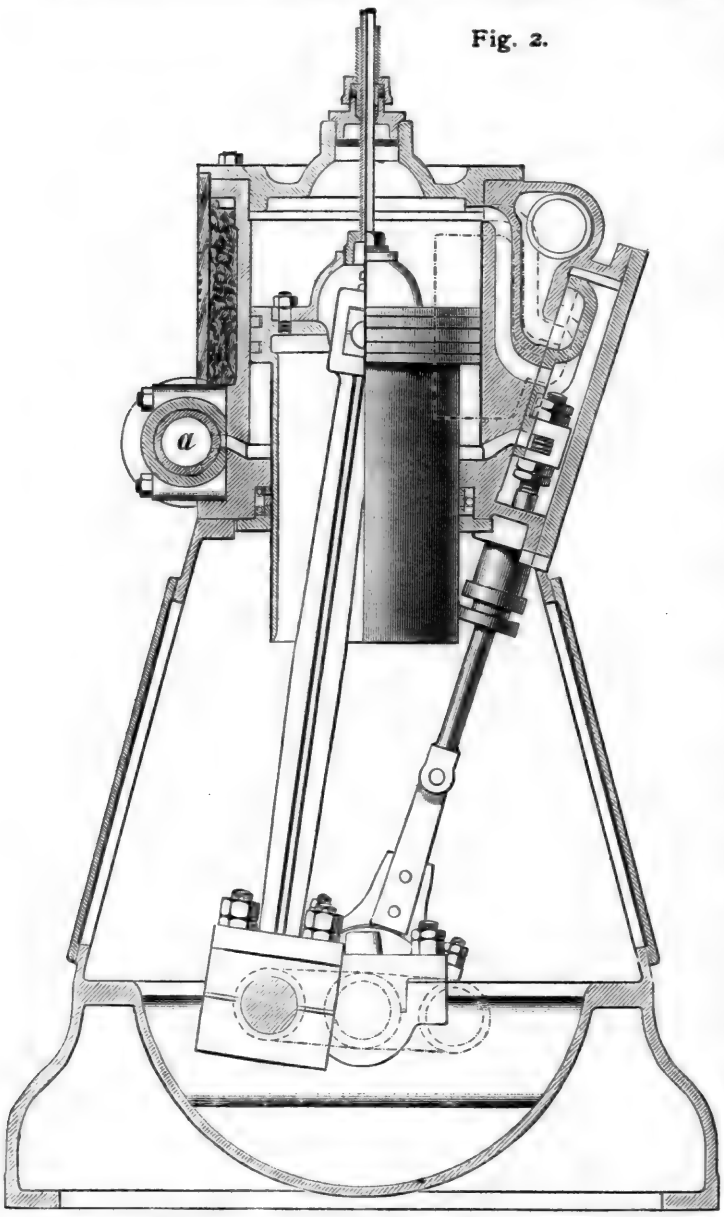
ber of bituminous. The weekly capacity of the furnaces in blast has increased from 142,734 tons to 151,684 tons.

"The appended table shows the number of furnaces in blast April 1, 1889, and April 1, 1888, with their weekly capacity:

	April 1, 1889.		April 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	63	12,150	60	12,393
Anthracite	100	33,267	95	27,971
Bituminous	161	106,267	130	75,983
Total	324	151,684	285	116,347

"The number of coke furnaces in blast, and the average weekly production, is greater than ever before in the history of the country, or, in other words, the rate of production of coke iron at the present time has never been exceeded. A year ago,

Fig. 2.



the time of the coke strike, the rate of production was fully a third less than it is to-day, and the reduced rate of production was not confined to those furnaces running on coke alone, but applied to furnaces in the anthracite region using coke as a mixture. Leaving out of consideration the charcoal furnaces, whose make is not influenced directly by the same causes that affect furnaces running with coke or anthracite, the production of the first three months of 1889 is considerably in excess of the production for a corresponding period of 1888."

The Jonson Balanced Compound Engine.

The accompanying illustrations represent a balanced compound engine, manufactured by the Jonson Foundry & Machine Company, of New York, the peculiar features of which are covered by patent. Figure 1 is a perspective view of the engine and fig. 2 is a section.

This engine is of the trunk type, and, as will be seen from the illustrations, consists virtually of four half-cylinders with cranks set opposite to each other, or at 180°, forming an equivalent for the ordinary high and low pressure cylinders. The area of the annular space between the trunk of the low-pressure or compound cylinder is equal to that of the high-pressure cylinder.

Thus, in the engine shown in the accompanying cut the compound cylinder is $12\frac{1}{2}$ in. in diameter, while the trunk is $9\frac{5}{8}$ in.; the difference iu area is thus 122 72—72.72 = 50 sq. in., which is about the area of a cylinder 8 in. diameter, so that this engine is equivalent to an ordinary compound engine with cylinders 8 in. and $12\frac{1}{2}$ diameter and 10 in. stroke. Steam is exhausted from the high-pressure end of each cylinder to the upper or low-pressure end of the same cylinder, so that the high-pressure end of one cylinder and its opposite low-pressure or compound one alternately form a complete half stroke.

Except when the engine is used for electric lighting purposes, or in very large sizes, where the slide-valves are necessarily of great area, the high-pressure steam and compound valve are made in the same casting, the high-pressure exhaust passing through ports in the valve to the low-pressure end of the cylinder; and by giving the steam, compound, and exhaust valves a definite lead, as determined by practice, both cylinders can always be made to work in unison. The two valves, however, being in the same casting and driven by a single eccentric—or in the case when the engine is used as a marine engine, by two eccentrics and an ordinary link motion—any change in this motion, as in using an automatic cut-off, affects the compound and exhaust as well as the live steam, and the makers therefore prefer to use for this purpose an independent steam valve, as shown in the cut. For marine engines the ordinary adjustable cut-off is generally used.

As above stated, where the valve area is large the builders generally prefer to divide it. They have now under construction an engine of this type of 275 H.P., which is to be used in an iron steam tender, which they are now building for the United States Government, and in this engine they use an ordinary piston valve for the high-pressure steam and a slide valve for the low-pressure or compound.

Where used as a stationary engine an automatic fly-wheel governor is used; this is not shown in the cut, as it is not an essential feature of the engine and as it presents no special peculiarities of construction.

The advantages claimed for this type of engine are compactness, freedom from vibration, low center of gravity, and the fact that, all the moving parts being exact reproductions of each other, it is perfectly balanced mechanically and can be run at a very high rate of speed, making it specially valuable for electric lighting purposes, where a quick-running engine is needed.

An engine of this type in operation runs with remarkable smoothness, showing little or no variation in speed when connected to or disconnected from a dynamo requiring about 35 H.P. It takes up very little room in proportion to the power, and appears to be adapted for a great variety of work, both as a stationary and a marine engine.

OBITUARY.

William Harrison, who died in Cincinnati, April 6, was an engineer of long experience. He was for 17 years employed in the office of the City Engineer. He located the Cincinnati & Eastern Railroad and had charge of part of its construction, and was also for some time Engineer of the Queen City Bridge Company.

Henry Freeman Gaskill, who died in Lockport, N. Y., April 1, aged 44 years, was born in Royalton, N. Y. He began business with the Penfield Block Company, in Lockport, and afterward entered the shops of the Holly Water-Works Company as a draftsman. His ability as a mechanical engineer was appreciated, and he rose rapidly to be Vice-President of the Company. He was the designer of the well-known Gaskill pumping-engine, which is manufactured by the Holly Company.

Edward P. Allis, who died in Milwaukee, Wis., April 1, was born in Cazenovia, N. Y., in 1824, and graduated from Union College. Soon after he went West and settled in Wisconsin, where he engaged in business. In 1860 he purchased a small foundry and machine shop in Milwaukee, which was then in a bankrupt condition, and which by his energy and careful business management was gradually developed into the present extensive works of the firm of E. P. Allis & Company, which are among the largest in the Northwest, and whose work is known

all over the country. It is understood that Mr. Allis has made provision in his will for the transfer of the business to his sons.

GENERAL CHARLES KINNAIRD GRAHAM, who died at Lakewood, N. J., April 15, aged 55 years, was born in New York, June 3, 1824. In 1841, when only 17 years of age, he became a midshipman in the United States Navy; after serving a few years he resigned and became a civil engineer. In 1857 he was appointed Constructing Engineer of the Brooklyn Navy Yard, and had charge of the building of the dry-docks there. In 1861 he joined the Union Army and served through the war, rising to the rank of Brigadier-General. General Graham was Chief Engineer of the Dock Department of New York City from 1873 until 1875, and Surveyor of the Port of New York from 1878 to 1883. In 1883 he was appointed Naval Officer, which post he held until 1885; since that time he has suffered much from sickness.

CHARLES F. HATCH committed suicide at his residence in Minneapolis, Minn., April 15. Mr. Hatch was about 60 years old, and was an engineer by profession. He was employed on a number of different roads, and about 1864 became Superintendent of the Michigan Southern & Northern Indiana; when that road was merged into the Lake Shore & Michigan Southern, Mr. Hatch became General Superintendent of the consolidated line, and remained there until 1874, when he came East, to take charge of the Eastern Railroad of Massachusetts as General Manager. His administration of the affairs of that road was a short one, and after two years' service he resigned and went West again, accepting the position of General Manager of the Minneapolis & St. Louis road. He was subsequently, for a time, General Superintendent of the Chicago, St. Paul, Minneapolis & Omaha, but resigned that office about 1883. Recently he was chosen President of the Wisconsin, Minnesota & Pacific Railroad Company, and held that position at the time of his death.

MICHEL EUGENE CHEVREUL, the distinguished French chemist, who for many years enjoyed the distinction of being the oldest scientific man in the world, died in Paris, April 9, 1889, at the great age of 102 years. He was born August 31, 1786, in Angers. In 1803 Chevreul went to Paris, where his aptitudes were quickly noticed. In 1806 he was appointed director of Vanquelin's laboratory, and a professor in the Lycée Charlemagne, and during the same year he published the results of his first experiments in the form of seven papers, of which three were on coloring-matters (indigo and Brazilian-wood). Four years later he was appointed *aide-naturaliste* in the Museum of Natural History, then examiner for the École Polytechnique; and at 30 he was Professor of Chemistry in the Gobelins, the world-known manufactory of tapestry, and director of the department of tinctorial baths. In 1826, after the death of Proust, Chevreul was appointed member of the Academy of Sciences. In 1830 he became Professor in the museum, and some time after Director. He never missed a meeting of the Academy of Sciences up to his one hundredth birthday. A catalogue of Chevreul's works would be a work in itself. The two most important branches of science studied and developed by him are the chemistry of fatty substances and the theory of complementary colors. A statue of Chevreul was unveiled at the Paris Museum on his one hundredth birthday.

PERSONALS.

ANDREW J. COOPER has been appointed City Engineer of Easton, Pa.

R. H. TEMPLE, of Richmond, Va., is Chief Engineer of the Tennessee Midland Railroad.

J. F. O'ROURKE has been appointed Resident Engineer on the construction of the Chignecto Ship Canal in Nova Scotia.

J. H. SAMPLE has resigned his position as Chief Engineer of the Louisville, St. Louis & Texas Railroad on account of ill-health.

JOHN C. PAUL has been appointed Superintendent of Equipment of Pullman's Palace Car Company, and will have his office in Chicago.

H. M. PERRY, for some time past with the Pullman Company, has been appointed Manager of the Southern Car Works, at Knoxville, Tenn.

ROBERT ANDREWS, who has been chosen Vice-President of the Safety Car Heating & Lighting Company, New York, was for a number of years connected with the Wabash Railroad as Chief Engineer and afterward as General Superintendent.

H. FRAZIER has been appointed Superintendent of Roadway of the Chesapeake & Ohio Railroad. He was recently on the Louisville & Nashville.

C. M. COOK has been appointed Engineer of Maintenance of Way of the Buffalo, Rochester & Pittsburgh Railroad, with office at Bradford, Pa.

CHARLES BLACKWELL has resigned his position as Engineer of the Machinery Department of the Central Railroad of Georgia. His address for the present is Savannah, Ga.

T. APPLETON has been appointed Resident Engineer on the Union Pacific, with headquarters at Omaha, Neb. He was recently Secretary of the Elastic Nut Company of Milwaukee.

F. E. NELSON has been appointed Superintendent of Road Department of the Atlantic & Pacific Railroad, with office at Williams, Ariz. He will have charge of roadway, bridges and buildings.

GEORGE F. EVANS, for some time past representative of the Eames Vacuum Brake Company, has resigned that position to accept a similar one with the McElroy Steam Heating Company, of Albany, N. Y.

JAMES H. WINDRIM has been appointed Supervising Architect of the Treasury. Mr. Windrim is a Philadelphian, and has designed the Masonic Temple, the College of Physicians, the new building of Girard College, and a number of other important structures in that city. He was also for a time Architect for the Pennsylvania Railroad Company.

JAMES E. CHILDS has been appointed Assistant General Manager of the Lake Shore & Michigan Southern Road, succeeding Mr. Harahan. Mr. Childs is an Engineer, and has served as such in the construction of a number of roads; for eight years past he has been with the New York, Ontario & Western as General Superintendent and General Manager.

ROBERT P. PORTER, of New York, has been appointed, by the President, Superintendent of the next census. Mr. Porter is a journalist, who has been employed on several prominent newspapers, and is the present Editor of the New York *Press*. In 1879 he was appointed Chief of the division relating to wealth, debt, taxation, and railroads in the census of 1880, and in 1882 he was Secretary of the Tariff Commission.

WILLIAM R. WARE, Professor of Architecture in Columbia College; CHARLES BABCOCK, Professor of Architecture in Cornell University; and JOHN BOGART, State Engineer and Secretary of the American Society of Civil Engineers, have been appointed as a Commission of experts to pass upon the plans submitted for the new Episcopal Cathedral in New York, which is expected to be the finest and most important ecclesiastical building in this country.

PROCEEDINGS OF SOCIETIES.

Northwest Railroad Club.—At the regular meeting in St. Paul, April 5, Mr. J. C. Barber read a paper on the subject of Freight Car Trucks, in which he urged that improvement was much needed in view of the greater weights now carried. This paper was discussed at considerable length by Messrs. Pattee, Mathews, Reed, Hill, and others present, all parts of the truck coming in for criticism.

New England Railroad Club.—At the regular meeting in Boston, April 10, the subject for discussion was Compound Locomotives, and a paper on the question was read. This called out a very lively discussion from members present, in which, as might have been expected, there were wide differences of opinion.

Western Railroad Club.—The regular monthly meeting, in Chicago, April 16, was occupied by a general discussion of the Rules of Interchange of the Master Car-Builders' Association, in which several disputed points were brought up. A committee of five—Messrs. Verbryck, Schroyer, Rhodes, Barr, and Crossman—was appointed to examine the Rules and make a detailed report to the Club at its next meeting.

General Time Convention.—The spring meeting was held in New York, April 10. May 12 was the date fixed upon for the spring changes of time. The proposition to change the name of the Association was laid upon the table.

The following officers were chosen: President, H. S. Haines; First Vice-President, F. Wolcott Jackson; Second Vice-President, J. T. Harahan; Secretary, W. F. Allen.

The Committee on Train Rules reported that the standard code was now in use by 64 companies, operating 39,132 miles, and would be adopted during the present summer by 26 other companies, operating 27,398 miles. Some slight amendments were proposed. The publication of the authorized edition of the standard code has been delayed owing to the non-completion of the full set of diagrams showing manner of using signals.

The Committee on Car Mileage and Per Diem Rate presented a report recommending charging demurrage, at the rates fixed at the October meeting, and the organization of bureaus at central points, to collect such charges and to prevent the detention of cars. The report was adopted, and the Committee instructed to prepare forms for the use of such bureaus.

Railroad Superintendents' Association.—A regular meeting was held in New York, April 8. The following officers were elected for the ensuing year: President, C. S. Gadsden; Vice-President, L. W. Palmer, J. B. Morford, Waterman Stone; Secretary, C. A. Hammond; Treasurer, R. M. Sully.

Several amendments to the Constitution were proposed, and the Secretary was authorized to submit them to members by circulars. The Roadway Committee reported that the time for receiving papers for the prize offered by the Association had been extended to May 1. The Committee on Machinery presented an elaborate report, in relation to Steam-Heating of Trains.

At the afternoon session a paper by Mr. Tratman on Improvement of Track was read and referred to a committee. There was some discussion on the Code of Signals.

President Gadsden read a paper on Discipline, which was generally discussed by members present.

It was resolved to hold the next meeting in New York. A committee was appointed to consider the question of procuring permanent headquarters in that city.

American Society of Mechanical Engineers.—The following circular has been issued by Secretary F. R. Hutton to members of the Society:

"The Council, at a recent meeting, canvassed the replies from the members in reference to the question of an up-town or down-town location of the Society's rooms and library.

"The result of that vote showed that a decided majority favor an up-town location, where rooms and library could be kept open in the evenings, but a general opinion opposed, at this time, to undertaking the responsibility of an entire house, with its increased cost.

"Arrangements have, therefore, been perfected in carrying out the expressed preferences of the voting members to secure such accommodations as would be suitable in the central or hotel district of the city. The Council have leased the entire ground floor of No. 64 Madison Avenue, New York, which will be the Society's address after April 20, 1889, until further notice. This house will offer to the Society three large rooms on the ground floor, well lighted and comfortably furnished, and suitable for the present needs of the library and office. The avenue location is a pleasant one, just above Twenty-seventh Street, and one block north of Madison Square, near all the hotels which have congregated at this section, and within three short blocks of the building on Twenty-ninth Street, which has been secured by the Engineers' Club. During the summer season, and until October 1, 1889, the rooms will be open as now, from 9 in the morning until 5:30 in the evening; but after that date it is proposed to have them open also in the evenings, in charge of a custodian, so that the members, both resident and non-resident, may be able to make use of them at hours when they are less pressed for time than during the business day. The library of exchanges and periodicals is steadily growing, and the current files of journals are open for consultation, to say nothing of the regular issues of the societies, American and Foreign, which are on the library shelves.

"A later notice in the autumn, after the return of the entire European party, will announce the beginning of evening openings. As stated above, this feature will not be inaugurated until October 1."

American Water-Works Association.—The annual convention was held at Louisville, Ky., April 16, 17 and 18. The list of papers to be read is as follows:

Water-Works Records, by J. M. Diven; Flushing Street Mains, by H. W. Ayres; Increased Revenue from Private Sources, by C. N. Priddy; Hydraulic Elevators Operated by Direct Pressure, by G. A. Ellis; Use of Liquid and Gaseous Fuels, by L. H. Gardner; Pressure Regulators for Water-Works, by William Ryle; Analysis of Mechanical Filter Actions, by Emil Geyelin; Water-Works Construction from an Engineering, Financial, and Municipal Point of View, by F. H. Pond; Classification of Water Rates, by J. Nelson Tubbs; Purification of Water for Boilers, by F. W. Gerecke; Standard Water Pipes, by D. B. Russell; Aeration and Sedimentation of Muddy River Water, by Professor J. B. Johnson; The Hardness of Water, by Professor A. R. Leeds; Relation between Plumbers and Water Companies and Departments, by B. F. Jones; Some of the Difficulties in Establishing a New Public Water-Supply and Its Improvement, by W. J. Milner.

Besides this programme opportunity was given for discussion of papers read, for the presentation of volunteer papers, and of questions for discussion by members. Arrangements were also made for social meetings, excursions, etc.

In connection with the meetings there was an exhibition of machinery and appliances for water-works manufactured by associate members.

Philosophical Society of Washington.—At the regular meeting, March 30, a paper was read by Mr. J. Elfreth Watkins, Curator of the Section of Transportation at the National Museum, on The Origin of the Railroad Systems of England and America, and the Causes of the Differences. Mr. Watkins first discussed the beginnings of modern transportation. The time was ripe for the railroad and the steam locomotive when it came. In England the demand for coal becoming more and more urgent as the forests disappeared directed thought toward the improvement of modes of transporting it from the collieries. The growth of the iron industry also called for cheap methods of procuring coal. Wooden rails, from the collieries to the water courses, on which cars were drawn by horses, materially reduced the cost of coal used for manufacturing and for household purposes. The improvements made by Watt in the steam-engine, between 1775 and 1785, aided in mining coal and increased the production. As coal was cheapened the price of iron was reduced, and it became possible to use iron rails for the tram-roads. Mr. Watkins traced the development of the rail and exhibited drawings of the rail, designed by Robert Stevens, of America, the first rail rolled with a base, which marks the American system.

The Engineers' Club.—The Engineers' Club has secured permanent quarters in New York, having leased a large double house on West Twenty-ninth Street, near Fifth Avenue, immediately opposite the Law Library. The house is large, and can easily be fitted up for the accommodation of the Club, which has already a large membership, and starts off with its affairs in excellent condition.

American Society of Civil Engineers.—At the regular meeting of March 20, Mr. Charles Macdonald delivered an interesting lecture on the Progress of the Forth Bridge, illustrated by stereopticon views from photographs taken at different times.

At the regular meeting of April 3, the Secretary announced that it had been decided to hold the next convention of the Society at Seabright, N. J., during the latter part of May, just previous to the departure of the European party, which is to be on May 29. The deaths were announced of John Ericsson, elected honorary member of the Society October 2, 1879, and of E. P. Allis, elected fellow of the Society August 4, 1883, and the preparation of the customary memoirs was directed.

A comprehensive paper by Emil Kuichling on Experiments on Flow in Combined Sewers, discussing the relation between rainfall and sewer discharge in urban and suburban districts, was read by the Secretary, and discussed by Rudolph Hering and others. The paper gave some results of practical experience gained by experiments and observation.

The tellers announced the following election:

Members: Willard Beahan, Santiago, Chili; Edward J. Blake, St. Joseph, Mo.; Horace J. Campbell, Chicago; William W. Coe, Roanoke, Va.; Fayett S. Curtis, New Haven, Conn.; John R. Freeman, Boston; Franz Germain, Colon, Isthmus of Panama; Frank P. King, Denver, Col.; John N. Pott, Wilkes-Barre, Pa.; John J. Robinson, Johnson City, Tenn.; Martinius Stixrud, Seattle, Wash.; Timothy S. White, Beaver Falls, Pa.

Juniors: William B. Ewing, Chicago; John E. Griffith, Donald, B. C.; Clifford S. Kelsey, New York; Curtiss Millard, Yonkers, N. Y.; Elstner Fisher, Benno Rohnert, Detroit, Mich.

At the regular meeting, April 17, the Secretary read a paper on the Mississippi as a Silt-Bearing River, by William Starling, Chief Engineer of the Mississippi Levee Commission. This paper was discussed by members present.

The Committee on the relation of the Sections of Railroad Wheels and Rails ask that discussions on the subject and replies to the circular of the Committee be sent in immediately.

Boston Society of Civil Engineers.—At the regular monthly meeting, April 17, memoirs on the late S. M. Felton and the late E. S. Philbrick were read. Messrs. W. C. Boyce, Edmund Grover, F. E. Hosmer, and F. B. Rowell were chosen members.

Mr. L. D. Bidwell read a paper on the Relocation of the New York & New England Railroad at the Sodom Dam. Mr. Samuel M. Gray read a paper on the Proposed New Terminal Facilities in Providence.

Engineers' Club of Philadelphia.—A regular meeting was held March 16.

Mr. J. E. Codman presented notes on a Test of Riveted Steel and Iron Plates, exhibiting the test specimens. These were discussed by Messrs. Marichal and Morris.

Professor L. M. Haupt presented notes upon the Permeability of Cements and Mortars.

A description of the Compound Steam Turbine and Turbo-Electric Generator, derived from a paper presented by Hon. Charles A. Parsons to the Institution of Mechanical Engineers of England, was presented by Mr. J. E. Codman.

At the regular meeting of April 6, the entire session was taken up in the presentation and discussion of a series of amendments to the constitution and by-laws of the Club. These amendments are to be voted upon separately by letter ballot at the next business meeting.

Engineers' Society of Western Pennsylvania.—At the regular meeting for April, the Committee on Transfer of Members made a report recommending a system of visiting cards, and was instructed to confer with other societies on this matter.

The Committee on Improvement of Country Roads presented a report, recommending a division of such roads into three classes, highways, roads and lanes, according to their relative importance, and also the appointment of road commissioners and of county engineers, to have charge and control of the improvement and maintenance of the roads. The Committee also presented a draft of a bill to be submitted to the Legislature carrying out these changes. The report was adopted by the Society, and the committee instructed to use every means to support the bill in the Legislature.

A paper on Optical Glass was read by Mr. John A. Brashear, giving an interesting account of the method of manufacturing this glass. He claimed that such glass ought to be made in Pittsburgh, as all the requisites could be obtained there, and it needed only the skill and patience of trained employés.

Engineers' Club of Cincinnati.—At the regular meeting, March 28, Messrs. A. I. Totten, William Archer, E. W. Wulfekoetter, and John G. D. Mack were chosen members.

In the absence of any regular paper, Mr. R. L. Read gave a lengthy and interesting description of the new freight depot and storage warehouse recently constructed under his supervision by the Cincinnati, Indianapolis, St. Louis & Chicago Company, at Cincinnati, to replace the old and inadequate sheds which have served for many years. These improvements are quite attractive and commodious, affording a large amount of storage room for flour and other goods, and convenient and well-adapted accommodations for the handling of the large freight business done by the road.

Mr. Anderson described a bridge which he had designed to carry a sewer drain across a ravine at the new military post being established at Newport, Ky. The bridge, which is a masonry arch of 60 ft. span, and having a rise of 6 ft., presents some original features of construction which were discussed at some length by those present.

Western Society of Engineers.—The regular meeting of the Society was held in Chicago, March 6.

Application for membership was made by Mr. John S. Glenn. Messrs. Edwin G. Nourse, James K. Lyons, Charles C. Brokaw, and Richard O'Sullivan Burke were elected members.

Mr. F. C. Rossiter, of the Committee on Standard Drawing Papers for Engineers, introduced some samples of profile paper which had been prepared for blue printing.

The Secretary presented the financial report of the month. The resignation of the Treasurer, H. W. Parkhurst, was received and accepted.

A committee of three was appointed to secure proper quarters for the Society.

The question of voting on the amendment to increase the annual dues was discussed by Messrs. Nagle, Liljencrantz, Lundie, Carter, and the Secretary.

A paper on the Croton Valley Storage, by Samuel McElroy, was ordered to be read at the next meeting.

Civil Engineers' Club of Cleveland.—The annual meeting was held in Cleveland, O., March 12. The reports of the officers showed the Club to be in a prosperous condition. The following officers were chosen for the ensuing year: President, W. R. Warner; Vice-President, H. C. Thomson; Treasurer, S. J. Baker; Secretary, James Ritchie; Corresponding Secretary, A. H. Porter; Librarian, J. L. Gobeille; Member of Board of Managers, W. H. Searles.

The annual dinner of the Club was given March 14, and there were present about 75 members and guests.

Civil Engineers' Society of St. Paul.—The regular monthly meeting was held April 1. Mr. Lehman was elected a member of the Society.

The paper of the evening was by Mr. E. E. Woodman, on The Legislative Control of Railways; this was discussed at considerable length by members present.

Engineers' Club of St. Louis.—The regular monthly meeting was held March 20.

Vice-President Nipher addressed the Club, on Plans of Investigations in Dynamo Designing. His remarks were illustrated by drawings and by formulæ and sketches on the blackboard.

Professor Johnson submitted a brief reply to Mr. William B. Knight's discussion of the paper on Cable Yokes. This was discussed by the members present.

At the regular meeting, held April 3, O. E. Hovey and H. Krutzsch were elected members.

A paper on Street Car Running Gear was read by Mr. B. F. Crow and discussed by Colonel Meier, Professor Johnson, J. A. Seddon, Mr. Robert Moore, Professor Nipher, Mr. Hubbard, and Mr. Taussig.

Mr. W. H. Bryan read a paper on Steam Plants for Electrical Service, which was discussed by members present.

Engineers' Club of Kansas City.—This Club has obtained a room of its own for meetings, which will also be used as a reading-room for the convenience of members.

At the regular meeting, April 1, R. L. McAlpine was elected an Associate Member. Letters were received in reference to the transfer of members and the subject was discussed, the general opinion being that some system of transfer should be arranged.

Mr. Taylor's paper on Strengthening Railroad Bridges was discussed by Messrs. Goldmark and Breithaupt.

A paper on Pollution, with special reference to water supply and sewerage, was read by Mr. Kenneth Allen.

Organic impurities were especially referred to; their detection by chemical and biological analysis; the character and action of bacteria briefly described; and the allowable limits of impurities mentioned.

After discussion by Messrs. Breithaupt, De Courcy, and Elliot, the President introduced Dr. F. B. Tiffany as a pupil of Dr. Koch, of Berlin. Dr. Tiffany exhibited specimens of Anthrax Bacilli, Infusoria from hay infusion, water from O. K. Creek sewer, and other specimens under microscopes magnifying 400 and 800 diameters.

Civil Engineers' Association of Kansas.—The following officers have been elected for the ensuing year: President, O. Mulvey; Vice-Presidents, W. A. Crusinberry and W. R. Kesler; Librarian, H. H. Jackman; Treasurer, Ransom H. Brown; Secretary, J. C. Herring.

At the regular meetings, held on the first Wednesday of each month, original papers are read and discussed.

Master Mechanics' Association.—The committee of which Mr. John Hickey, of the Milwaukee, Lake Shore & Western road, is Chairman, has issued a circular of inquiry in relation to the question as to whether the Water Space Surrounding the Fire-Box and the Flues of Locomotives is Usually Large Enough for Free Circulation.

Another circular has been issued by the Committee on Tires, of which Mr. Henry Schlacks, of the Illinois Central, is Chairman, requesting information on the Wear of Tires and upon

the Relative Advantages and Disadvantages of Using Heavy or Light Tires on Locomotive Driving-wheels.

Montana Society of Civil Engineers.—At a meeting held in Helena, Mont., March 16, the Committee on Highway Bridges reported in favor of co-operating with other engineering societies to secure the desired reform, but considered that it is not expedient, in so new a country as Montana, to attempt the passage of any inspection law at present. This report was adopted as the sense of the Club.

Master Car Builders' Association.—The following is the letter of resignation of Mr. Forney, which was submitted at a meeting of the Executive Committee held on March 15.

New York, March 14, 1889.

To the Members of the Executive Committee of the Master Car Builders' Association:

Gentlemen: As other interests demand all of my time and attention, I have decided that I will not accept a reappointment as Secretary of the Master Car-Builders' Association should it be tendered to me after the next annual convention. As the business of last year has all been completed, and little or none of that for the current year has yet begun, it seems to be desirable, if a new incumbent of the office is appointed, that he should assume its duties before rather than after the convention, so that he will become familiar with the business which must be transacted during the meeting, which must be embodied in the annual report for the current year. For these reasons I hereby request the Executive Committee to relieve me of the office and duties of Secretary of the Association at as early a date as it may be possible to agree upon my successor.

In relinquishing my official relations to the Association I feel sure that it will be a pleasure to me hereafter to remember the acquaintances and friendships which have been made during the time that I have occupied the position of Secretary and to recall the period of my term of office. Trusting that the pleasant personal relations of the past will be continued and that the prosperity and usefulness of the Association may increase in the future, as it has in the years that are left behind, I am,

Very respectfully,

M. N. Forney.

The letter was received by the Committee, and a resolution was adopted that Mr. Forney's resignation be accepted, to take effect as soon as a successor in the office of Secretary is installed. Mr. John W. Cloud was then appointed to fill the vacancy; he has since then accepted the office, and may be addressed at Buffalo, New York.

NOTES AND NEWS.

The Laon Steep-Gradient Railroad.—The tramway laid down along the highroad to connect Laon with the station of the Northern Railroad of France has a gauge of 1 ft. 11⅝ in.; its rails are of steel, weighing 19½ lbs. per lineal yard, carried on steel sleepers, 3 ft. 3½ in. long, hollow underneath, and closed at the ends on Captain Pechot's system. The line, which surmounts a difference of level of over 328 ft. in about 1¼ mile, has necessarily steep gradients, reaching to 1 in. 15.4, with curves having a minimum radius of 1½ chain. The traction is effected by a compound locomotive, on the Mallet system, weighing 8.8 tons when empty, and 10.8 tons when loaded. This engine has four axles, to make the load borne by each as small as practicable; all its wheels are driving-wheels, to utilize the whole weight of adhesion; and the front set of wheels are made convergent, so that the engine can go readily round curves of one chain. The heating surface is 254 sq. ft.; the hinder, high pressure cylinders have a diameter of 6¾ in., and 10¼ in. stroke; while the front cylinders, low-pressure, have a diameter of 10 in., and the same stroke; and the wheels are 1 ft. 11⅝ in. in diameter. The total wheel-base is 9 ft. 2 in.; but the distance apart of each pair of axles is only 2 ft. 9½ in. The locomotive has a tractive force of 1.43 tons at the tires of the wheels when running compound, but by the admission of live steam into the four cylinders, this force can be raised to 2.07 tons. This latter method of working, however, is only exceptionally used, to overcome excessive temporary resistance. The carriages are on trucks, and have seats for 24 passengers, and standing-room for eight more; so that the ordinary train of three carriages can convey 96 passengers, amounting, when filled, to a load of 12 to 13 tons. The laying of the line was effected by 50 workmen in three days with satisfactory results.

The Vestibule Car Patents.—In the United States Circuit Court, in Chicago, April 17, a decision was given declaring the Sessions patent on vestibule cars valid, and holding that the Wagner Company was infringing it. The Court held that none of the patents brought up anticipated the Sessions invention, and that the old devices brought forward to invalidate it were without standing. It was therefore ordered that the temporary injunction against the Wagner Company be made permanent, and that a master be appointed to take testimony as to damages.

The Sessions patent covers the iron face-plates on the vestibules, held together by springs, which make a tight joint between the two vestibule portions of the car, when the train is in motion.

The Wagner Company claims that this decision will not prevent them from using the vestibule cars, as the platform arrangement can be successfully used without this device, and others can be substituted for it.

A Cuban Bridge.—A Cuban Exchange describes a new iron bridge recently erected across the valley of the Purial River, on the Soledad & San José Railroad, in that island. The total length of the bridge is 360 ft. divided into 10 spans, the longest being 72 ft., the others of 35 ft. 9 in. and of 18 ft. The bridge is supported by two stone abutments, one stone pier and 8 iron piers or towers, resting on stone foundations. The iron used is old rails, 18 ft. in length. The iron towers or piers each consist of 12 rails set upright and covered with a wrought-iron cap, upon which the trusses rest.

In the short spans the lower chord consists of a single rail, the upper cord of two rails, held together by bolts 1¼ in. in diameter, passing through thimbles or distance-pieces, which hold the two rails at the proper distance apart. In the 72-ft. span the lower chord consists of two rails, and the upper chord is in the form of an arch; the truss is braced by 32 rods 1¼ in. diameter and 16 1-in. rods, extending from chord to chord. This truss is 10 ft. 4 in. in depth, and the trusses are spaced 11 ft. 8 in. apart from center to center. The lower chord is 30 ft. above the level of the river. One of the iron piers is 13 ft. in height from the stone foundation to the iron cap, and the others are 26 ft.

The bridge was calculated to support a moving load of 63 tons, on each 36 ft. in length, trains to run at a speed of 25 miles an hour. In testing the bridge a train consisting of a locomotive 21 tons in weight, and nine cars heavily loaded with wood, was used, and tests were made with the train at rest and running at full speed. It should be observed that the trains pass upon the bridge from a heavy down grade.

This bridge was built for Mr. John W. Hoes in the shops of the Guantanamo Railroad, by Mr. Walter S. Phelps, Superintendent of Machinery of the road.

We may here mention that the shops of the Guantanamo Railroad, under Mr. Phelps's charge, have, during the past four years, built a locomotive—the first complete locomotive ever built in the Island of Cuba—a steam-car, the iron bridge above mentioned, and another one 200 ft. in length, a new passenger car, and furnished repairs and new machinery for 22 coffee and sugar plantations, besides doing all the regular repair work of the railroad, making a variety of work not often found in a railroad shop.

Passenger Travel on German Railroads.—The statistics of the German railroads for last year show a considerable increase in passenger travel, the total number carried rising from 295,758,906 in the preceding year to 315.991.747. The increase in mileage of the roads was not large, the average in 1887–88 being 39,261 kilometers against 38,261 in the preceding year. The first class alone decreased, all the other classes having increased in number. Germans travel much, but in this, as in all other things, they are thrifty, and spend as little as possible. The great bulk of the passengers on German roads take the cheaper class of cars, so that the first class are very little patronized. The division of passengers for two years past was as follows:

	1887–88.		1886–87.	
	Number.	Per cent.	Number.	Per cent.
First class	1,807,647	0.4	1,864,596	0.6
Second class	32.869,910	10.4	31,724,493	10.7
Third class	206.624.435	65.4	193.131,225	65.3
Fourth class	67.359.874	21 4	62,081,560	21.0
Military	7.329.881	2.4	6,957.032	2.4
Total	315,991.747	100.0	295,758,906	100.0

The number of fourth class passengers would probably have been greater, but for the fact that on nearly all the South German Railroads there is no fourth class, the third class being the lowest in use. The third and fourth class together last year included 86.8 per cent. of all the passengers carried.

Railroads in the Philippine Islands.—The first railroad in the Philippine Islands was recently opened for business. It is a narrow gauge line, five miles in length, extending from Manila to Malabon, on the southwest shore of Manila Bay, where a large sugar refinery is in active operation. The road

is solidly built, the bridges being of stone. It is equipped with four locomotives of German manufacture, and with a passenger car and 10 freight cars of English make.

Work is in progress on a narrrow-gauge line from Manila to Dagupan on the Island of Luzon, which will be 120 miles in length. Lines are also proposed from Manila to Cavite, about 30 miles, and from Manila to Antipolo, 18 miles, but work has not been begun. The Island of Luzon is very densely populated and very productive, and could, it is thought, furnish traffic for these lines without difficulty.

A Revolving Battery.—The accompanying illustrations show a design recently patented for a revolving marine battery, which may be properly described as being a monitor turret set afloat by itself, without a monitor hull under it. The hull of the vessel, as will be seen, consists of two concentric rings con-

Fig 1

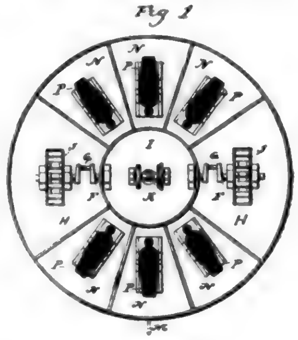
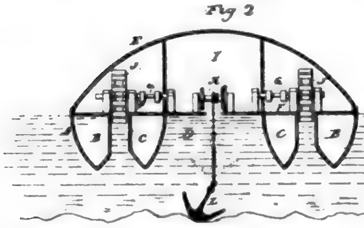


Fig 2



nected so as to form one structure, leaving a clear central space within. The battery itself is made of dome shape, and engines are provided for manœuvring the ship, if it may be called so. These engines are so arranged that they can be used to propel the battery from one place to another, a temporary rudder being provided for this purpose, or they can be used to revolve the turret in the water when anchored, as shown in fig. 2.

Incidentally, it may be remarked that this construction bears a sort of family resemblance to the circular monitors or *Popoffkas*, as they were called after their inventor, a number of which were built some years ago for the Russian Navy. The Russian authorities never made public any particulars in relation to these singular vessels, but it has been generally understood that they were not by any means a success.

The battery shown here is the subject of United States patent No. 400,836, dated April 2, 1889, and granted to Lockwood Durand, of Huntington, Conn.

Swiss Cable Railroads.—Several new cable roads are to be undertaken in Switzerland during the present season. A contract for a cable line from Acluse to Plau has been let; this road will be about 1½ miles long, with an average grade of about 15 per cent.

Another line in progress will run from St. Gall to the summit of one of the neighboring hills. It will be about 11,000 ft. in length, with grade varying from 19 to 25 per cent.

A third line to be built will extend from Lauterbrunnen to Murren. From Lauterbrunnen to Gratsch this will be a cable railroad, the cables being worked by water-power; from Gratsch to Murren it will be an electrical line, the dynamos furnishing the power being also worked by water.

International Congress of Applied Mechanics.—There will be held at Paris, at the Conservatoire des Arts et Métiers, an International Congress of Applied Mechanics, under the patronage of a Committee of Honor comprising savants and engineers of renown both from France and from other countries, who will give the work of the Congress the benefit of their influence and the weight of their authority. The President of the Committee on Organization is M. Phillips, ex-Inspector General of Mines. The five members appointed from the United States are, in the order of their mention on the official bulletin, Robert Grimshaw, Professor R. H. Thurston, Professor Egleston, and the Presidents of the American Societies of Civil and of Mechanical Engineers.

At this Congress, among the important subjects submitted for discussion are the unification of the horse-power; the choice of materials in machine construction; the mechanical production and utilization of artificial cold; transmission to a distance and distribution of work by other means than electricity (water, air, steam, cables, etc.); automatic cut-off engines, with several successive cylinders; thermo-motors other than the steam-engine.

Other topics, treated by papers, will be improvements in steam-engines since 1878; progress among associations of owners of steam appliances; and improvements in apparatus for the generation of steam, more particularly sectional boilers.

Foreign Naval Notes.—The new Russian ironclad which has been commenced at Nicolaieff will be called the *Twelve Apostles*. It will be 8,076 tons displacement, and will be protected by a belt of armor of 14 in., and will be provided with engines developing upward of 8,500 H.P. The *Hangut*, another vessel for the Russian Navy, of 6,590 tons, has just been laid down at the Admiralty works, St. Petersburg. This vessel will have only a partial armor.

The British Admiralty programme for the building of new ships does not involve so large an addition to the Navy as was hoped for, but as regards the types of ships to be built appears eminently satisfactory. Eight large battle-ships are to be built. They will be really enlarged *Trafalgars*, of over 14,000 tons displacement and 17½ knots speed under forced draft. Their armor belt near the water-line will extend two-thirds of their length, and will be 18 in. thick, and the upper part of their broadside will be protected by 5-in. armor, which will keep out the shot of quick-firing guns. The second-class ironclads will be similar in design to the first-class, but will have lighter armor and armament and will be of 9,000 tons displacement.

A number of first-class cruisers are to be built to steam 20 knots, with a displacement of 7,350 tons, having no side-armor, but a 5-in. armored deck. A second-class cruiser, of which a large number will be built, will steam 20 knots, with a displacement of 3,400 tons, and will have a 2-in. armored deck. Besides these there will be some cruisers of another type for distant service, and some more torpedo gun-boats. Half of the new vessels will be built in the Royal dockyards, and half by contract.—*Nautical Magazine.*

The Gatling Torpedo Boat.—The accompanying illustration shows a combined torpedo and gun-boat, designed by Richard J. Gatling, of Hartford, Conn.; fig. 1 being an elevation, and fig. 2 a deck plan of the vessel. The essential object of this design, as stated by the inventor, is to provide, in connection with a light-running and noiseless steam launch of great speed, a spar or boom capable of changes of position, an explosive or torpedo carried by said spar with improved machinery for operating it, a gun for throwing a high explosive against the side of a ship to be destroyed, and an annex or compartment for the torpedo operators attached to the stern of the boat, so that the boat itself becomes a shield to protect the operators from shots

Fig. 1

Fig. 2

directed at them while approaching an enemy's vessel. The general design will be readily understood from the engraving.

No special construction of hull or engines is provided for, the main requirements of such a boat being, of course, the greatest possible strength, combined with speed and lightness.

This design for a combined torpedo and gun-boat is the subject of letters-patent 399,516, dated March 12, 1889, and granted to Richard J. Gatling.

Railroads in New South Wales.—The report of the Commissioner of Railroads, for the year ending June 30, 1888, shows that on that date there were in operation in the Colony 2,112 miles of railroad, of which 197 miles were added during the year. There were 66 miles of new road under construction, a smaller amount than for several years past. The total cost of the railroads has been about $138,000,000, and their net earnings last year were somewhat less than 3 per cent. on the capital invested. The report complains that the earnings of the roads had been somewhat restricted by lack of equipment, and that more cars were urgently needed, but could not be procured, owing to the failure of the Legislature to make the necessary appropriations. All the lines are owned by the Colony.

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THE offices of the RAILROAD AND ENGINEERING JOURNAL were on May 1 removed from No. 45 Broadway to No. 145 Broadway, on the corner of Liberty Street. The correct address of the JOURNAL will therefore be hereafter No. 145 Broadway, New York City.

UNTIL recently the quickest passage on record across the Atlantic Ocean was made by the *Etruria*, of the Cunard Line, in September, 1888, the time being 6 days, 2 hours from Queenstown to New York. This has now been beaten by the new Inman Line Steamer, *City of Paris*, which arrived in New York, May 8, having made the run from Queenstown in 5 days, 23 hours and 7 minutes. The distances made on each day of the voyage, by the ship's log, were: 445 miles; 492; 504; 505; 511; 398; total, 2,855 miles. The average per day was thus 478.77 miles; the average per hour for the whole voyage, 19.95 miles; and the average per hour for the best day's run was 21.28 miles. The weather was generally good except on one day, when a slight shifting fog forced the vessel to slow down several times. The engines averaged about 88 revolutions per minute, and the coal consumed averaged 320 tons per day.

The *City of Paris* is a sister vessel to the *City of New York*, of the same line, which was described and illustrated in the JOURNAL for September, 1888, page 411. There are some minor differences, but the general dimensions and arrangements are the same. The *City of Paris*, however, has made this exceptional run on her second westward trip across the Atlantic, while the *City of New York* has so far made no remarkable time.

THE Paris Exposition has been duly opened according to the programme, and from all the accounts received promises to be a very successful one. As appears to be universally the case with such Expositions, much still remained to be done on the opening day, but the work of reducing the different departments to order was proceeding very rapidly, and probably by this time everything is in proper shape. The exhibit of the United States, of which some description will be given hereafter, is a very creditable one, although not so extensive in some departments as had been hoped for.

A REMARKABLE example of what may be accomplished at very small expense under intelligent direction, may be found at the Lehigh University, where the appropriation of an old wooden building, disused for other purposes, and the expenditure of a few hundred dollars has made what may be called an hydraulic laboratory, exceedingly valuable for practical instruction and also for the purpose of making tests. Of course a better arrangement could have been made had there been more money at the disposal of Professor Merriman, who was the designer and architect, but the very best use has been made of the means available, with results that are well worth inspection. In this little building observations are made as to power developed by turbines, consumption of water, and many other practical points of much use to the hydraulic engineer. The great drawback at present is the absence of a proper reservoir in which water can be stored, so that in a dry season the use of the building is limited by the supply of water.

THE running of Sunday trains has been a subject of some discussion and considerable agitation lately. The American Sabbath Union some time ago issued a circular in relation to running Sunday trains, to which responses were received from a large number of railroad officers, the majority favoring the suspension of Sunday work. The question has been taken up by some prominent railroad lines, and President Depew, of the New York Central, has announced that on that line the running of all Sunday trains, unless strictly necessary, is to be suspended.

With the present organization of our social and economical system a complete stoppage of trains on Sunday does not appear to be possible, especially in the neighborhood of our large cities; but it does seem as if a great deal of the work now done on the first day of the week might be avoided. The railroad man ought to have his day of rest as well as any other American citizen, and by proper management it could be secured to him. That he would be benefited by his Sunday off there can be no doubt, for hardly any class in the community is, as a rule, more intelligent or more ready to take advantage of opportunities.

UNIFORM SAFETY APPLIANCES ON RAILROADS.

THE Interstate Commerce Commission has issued a circular—reprinted on another page—which may be regarded as the first reconnoissance in a contest which will probably last for some time, and may be exciting before it is ended. At present there are probably 2,000 railroad employés killed and 10,000 more or less seriously injured annually on the railroads of this country. That railroad companies and their officers will resent any interference which will compel them to give greater protection to the lives and limbs of their employés may be expected. Not that such officials have less humanity than any other class, but mankind generally, and especially that part of it which is placed in official position, is prone to make for itself little puddles of prejudice, ignorance, and indolence in which it loves to wallow, and is quite sure to resist being disturbed, no matter how urgent the reason is for doing so.

The fact that traffic is now not only national but international—that cars from California may be found in New Brunswick, and that those whose home is near the Halls of the Montezumas—metaphorically speaking—are at times sheltered under the ramparts of Quebec—is reason why the question of railroad safety appliances cannot be adequately controlled by local State commissions, but should be under interstate or, perhaps, international authority. To secure the adoption of uniform safety appliances all over the country is a very big contract, and the Interstate Commission will find that the difficulties in the way of accomplishing that end are very great. In the first place, it is not easy to know what should be done. Who is there who would be regarded as adequate authority for saying what coupler will save the most lives and be the least dangerous? How should dead-blocks, ladders, steps, running boards, "grab-handles," etc., be arranged so as to give the greatest protection to life and limb? With the multiplicity of methods of heating and lighting cars, which one should be used? and as those arts are still in the evolutionary stage, if one of them is the best now, will it continue to be the best? If the Interstate Commission undertake to say authoritatively which is the best, they will be obliged to establish a bureau of railroad engineering, and then the responsibility will be transferred from the railroad companies to the shoulders of the Commission.

The circular is addressed to the labor organizations of the country, and its general purport is an inquiry as to what ought to be done. Whether the Commission will get much information from the members of these organizations remains to be seen. As a general thing, laboring men seem to take very little interest in questions which relate to the security of life and limb in the occupations in which they are engaged.

A very full investigation of the question of legislation with reference to Railway Accidents was made by a Commission appointed by the British Parliament in 1874. This Commission made an elaborate report in 1877, which, with the evidence submitted, forms a volume of more than 1,200 pages. It is full of interesting and valuable information which would be profitable reading for railroad managers and railroad commissioners generally. It contains a great deal of testimony bearing upon the question of legislation for the prevention of railroad accidents. Some of the evidence was given by T. R. Farrer, Esq., Permanent Secretary of the Board of Trade, who, we believe, has since then been knighted, and by Captain, now Sir Henry Tyler, who for a long time was an inspecting officer of the Board of Trade, which in Great Britain exercises more or less control over the railroads of the kingdom. A considerable amount of inquiry was made by the Commission with reference to the advisability of enlarging the powers of the Board of Trade for the prevention of railway accidents. Quite naturally there was much difference of opinion among those who gave the testimony to the Commission. It may, however, be assumed that persons who have been engaged for years in the investigation of the subjects to be legislated on would know more about them than any one else. The fact that the gentlemen named had occupied such prominent positions on the Board of Trade gives their testimony especial value, and also more weight than that of any other witnesses could have. It might also be expected that the members of a board of this kind would naturally seek for an extension of their authority, as a lust for power is usually a besetting vice of officials of all classes. This estimate of the value of their testimony is, however, confirmed by the fact that both the witnesses named were strongly opposed to any, or, at least, favored very little extension of the power of the Board. Their testimony with reference to the limits of Government interference with railroad companies may, therefore, be accepted with more confidence than it could be if those who gave it sought an extension of their authority and privileges.

In a "memorandum" on the expediency of creating additional powers for the prevention of railway accidents, after referring to the fact that some companies had not readily adopted improvements in railway construction, Captain Tyler said:

> At the same time it is to be observed that during the past five years such improvements have made much more rapid progress than during any previous period of railway history. The series of annual general reports on accidents, in which all the causes have been minutely analyzed, and all the remedies carefully set forth, has been mainly instrumental in producing this effect. The weak points on various railway systems have thus been demonstrated. . . .
>
> If only the same process be continued, the same care be taken, and the recommendations found necessary be persistently and publicly made in the same way from year to year, similar beneficial effects may be expected to accrue in future years with constantly accumulating force; and the railway system of this country will attain generally a very high degree of efficiency in all respects, including matters appertaining to public safety.
>
> The companies have in this way been induced, under the stimulus of official recommendation, backed by well-informed public opinion, themselves to carry out improvements in construction, appliances, or working, in the success of which they were mainly interested. They have satisfied themselves of their utility before adopting them, and have employed them on their own responsibility. They would not have the same interest in the successful working of improvements forced upon them under the orders of a tribunal, and many other disadvantages would be experienced in the application of any other form of direct compulsion. The companies would be partially relieved from their responsibilities, further invention and improvement would to some extent be discouraged, and undue responsibility would inevitably be thrown upon the tribunal. So long as railways are in the hands of companies, working for a profit, they must be managed by the officers of those companies. The directors and officers being directly exposed to the influence of public criticism, a more powerful effect may thus be produced on them than that which they feel from any pecuniary obligations which they may or may not incur in cases of accident. But if, in working their various systems, under different conditions and in different localities, they were subject to the direct instructions of a general tribunal, they would then be able to plead in the event of an accident that they had not been called upon to provide the means by which it might have been avoided. The responsibility might thus be thrown back upon the tribunal, and public opinion would be diverted, with the eager assistance of the legal advisers and officers of the companies, toward the proceedings of the tribunal, which would be ill able to defend itself, and would be exposed from time to time to the obloquy of not having been sufficiently active in requiring improvements in various parts of the country, by means of which serious accidents might have been avoided. The tribunal, helpless as to any control over the actual working of the railways or the discipline maintained among the servants of the companies, would, when thus attacked, become, in self-defense, more and more exacting, and its tendency would be to err in the extreme of excessive interference. Its end would be ignominious, under a joint and hostile outcry from the companies and the public. It would be accused at once of meddling mischievously and of not interfering sufficiently, and would fall under the imputation of inefficiency and want of judgment as accidents occurred to afford, rightly or wrongly, opportunities for angry criticism. Questions of compensation to injured passengers would also be materially complicated, as blame was bandied backward and forward between the tribunal and the companies.
>
> There would, of course, be the greatest difficulty in determining the amount of interference which such a tribunal should exercise. There are many well-recognized requirements; if the tribunal had power to enforce any of them, it should enforce them all. It would be almost impossible to draw a line. On

the discovery of any new means of safety, real or supposed, the tribunal would have power to enforce its adoption. If it should turn out to be less successful in practice than was expected, or if it should in some unforeseen way lead to mischievous results, the position of the tribunal would not be improved, and an outcry at one time for the universal adoption of some particular improvement might be succeeded by another outcry at some other time for its abolition, or for some other improvement in place of it.

Looking to the history of the past five, ten, and twenty years, respectively, it will be seen that improvement, which has been more or less gradually progressive, has also advanced more rapidly within the shorter periods, and it may be taken for granted that further improvement will continue to be made in almost every branch of railway construction and apparatus. While recommendations, as at present made, may be general, and may deal with principles, any attempt to compel companies to adopt them would necessarily deal with specific apparatus. The requirements enforced by any tribunal would, therefore, be specific, and the tribunal would be obliged to prescribe the particular appliance and apparatus to be adopted, or, in other words, to decide between competing inventors on the respective merits of their inventions. What was considered to be the best at a particular period would be insisted on for application on all railway systems, and its general adoption would tend to act as a bar to future improvement.

In giving his testimony, Mr. Farrer, the Secretary of the Board of Trade, submitted in writing a short outline—which he said he had prepared carefully—of what had occurred to him on the subject of the limits of Government interference with railway companies, from which the following extracts are made.

1. The railway companies have no right to object to any interference requisite for securing the public safety. They have a monopoly of public traffic, and are bound to do whatever is necessary for that object.

2. Nor is it necessary to argue that railway administration is perfect. It may be admitted that though their business is in general well and ably conducted, they are sometimes poor, sometimes niggardly, sometimes slow, and sometimes obstinate. Railway companies have also some of the defects of public departments in the size and cumbrous character of their official machinery, and in the remoteness of the bearing of the important motive of self-interest on the directors and managing officers. . . . .

5. But after all these admissions, general interference with the administration of railways is objectionable on the following grounds:

6. By such interference you are setting two people to do the work of one. Double management is notoriously inefficient. One bad general is better than two good ones.

7. You set those who have less experience of management and less personal interest in the result to control those who have more.

8. Control is either apt to become formal and a sham, or if zealously and honestly exercised, to be rigid, embarrassing, and a hindrance to improvement.

9. Many excellent things, the adoption of which is desirable for public safety—*e.g.*, the block system, interlocking points and signals, efficient brakes, properly constructed tires, are not things which can be once for all settled, defined and prescribed, but things of gradual growth, invention and improvement. Had any of these been prescribed by law at any past time they would probably not have been what they are now, and were they now prescribed and defined by law future improvement would be checked. This is a most insidious form of evil, for we do not know the good which we thus prevent. It is no answer to say that Government control would be intelligent, and would encourage improvement. It is not Government or its officers who invent or adopt inventions, and those who do so are far less likely to improve when Parliament or Government has defined and prescribed a definite course, the adoption of which frees them from responsibility. . . .

12. Lastly, it is impossible to maintain at the same time any general system of Government control, and any effectual responsibility on the part of the companies. At present the companies are responsible to public opinion and to Parliament, before which they have constantly to appear, and they are under heavy liabilities for accident and danger in courts of law. Once admit Government control and these liabilities are at end. No one can find fault with a company for that which the Government has sanctioned. With a system of control, even Government inquiry will be useless, for the Government officers would be inquiring into their own acts. . . .

15. It is scarcely necessary to add that the reasons against Government control which are above advocated are entirely consistent with a thorough system of Government inspection and investigation. The function of throwing light on all parts of the railway system; of investigating all alleged dangers, whether accidents have happened or not, and of ascertaining the true cause of accidents which do happen, is one which the Government can exercise with the utmost possible advantage and without fear of dangerous results. It is one which is useful to the companies; for it points out to them real sources of danger, and relieves the public mind where there is unfounded apprehension of danger. It brings to bear on the companies the powerful motives of fear of public opinion, of Parliamentary pressure, of apprehension of loss of traffic, and of legal liability for damages. And it does this without ulterior ill consequences. It is because these forms of remedy are in reality of very great efficacy, and because they are inconsistent with Government control, that I deprecate the latter.

The Board of Trade, the Secretary said, had relied more upon publicity than upon any legislative action, and as he took occasion to say further, "they have thought that whereas it was not expedient as a general thing to interfere with the working or management of railways, it was the business of the Government to throw light upon everything which occurred on railways and upon the causes of accidents."

But, it may be asked, supposing that the Interstate Commission should have authority delegated to investigate and report on accidents, and the railroad companies inertly do nothing toward adopting appliances and precautionary means to prevent accidents, should not Congress adopt compulsory measures? It is not well to anticipate too much. When compulsion is needed, the necessity will make itself apparent. The Interstate Commission can occupy itself very profitably for the present in showing where compulsion is needed, and when this is made clear, Congress will not be slow in exercising its authority. The Commission asks what should legislation attempt to accomplish in regard to couplers; in regard to train-brakes; in regard to car heating and lighting, and in regard to other matters.

The trouble here lies in knowing just what ought to be done. There ought not to be much difficulty in having a law passed compelling railroad companies to use a certain kind of coupler, if it could be made clear to Congress that its general adoption would be instrumental in saving lives and limbs, without incurring other equally or more serious evils. Here is where the difficulty comes in. The Interstate Commission ought not to advise nor Congress compel the adoption of automatic couplers or steam heating for cars, nor continuous brakes for freight trains, without knowing that it is practicable to use them, and that the ends sought will be accomplished thereby. To illustrate the danger which lies in this direction, it may be said that only a few years ago, when the adoption of automatic couplers was made compulsory by legislation, one Company adopted a form of coupler and applied it extensively to its cars, which afterward proved to be a complete failure. The Company wasted many thousands of dollars, and no good was accomplished. The managers of the line referred to, after investigating the matter, made the mistake of recommending the coupler which was adopted. The Interstate Commerce Commission would probably be no less liable to make mistakes of this kind, which, if enforced over the whole country, would be very serious. The Commission may profitably lay to heart the advice of the elder Crockett, "Be sure you are right before you go ahead." The work of the Commission in securing the adoption of safety appliances must for a considerable time be tentative, and its recommenda-

tions must be confirmed by abundant experience. They ought to have full power to make investigations into the causes of accidents, and make these causes public, and for the present such powers would be their strongest weapons, which they could wield with little danger to themselves but with much benefit to the public, and without seriously antagonizing the great power and the influence of the railroad companies against their beneficent work. The time may come when compulsory legislation may be demanded, but there is great danger in the exercise of such power. To give authority to enforce the adoption of safety appliances would, in the present state of our civil service, almost certainly lead to corruption. Such power would be an invitation to bribery, and many of the promoters of patented devices would be only too ready to blind the eyes and pervert the judgments of any or all who could exercise it.

There are some precautions for the safety of railroad employés, such as a maximum and minimum height of draw-bar, a standard form of wheel tread and flange and width of gauge of wheel, the form, proportions and height of dead-blocks, and a minimum clear space between cars when the dead-blocks are in contact, which certainly should be generally adopted ; but a distinct recommendation of these, and the fact that the neglect to act upon such a recommendation would incur more or less legal responsibility for injuries to employés, would for the present, at least, be authority enough. To compel all the railroad companies of the country to adopt some system of steam heating for cars, continuous freight car brakes, automatic couplers, and improved signals would involve the expenditure of many millions of dollars, and would bankrupt some of the weaker lines. The consequence would be, if it had the power to compel the adoption of such appliances, that pressure would constantly be brought to bear on the Commission to recommend only such as the poorer roads could afford to put on.

A system of inspection which would take cognizance of over a million of cars and some 28,000 locomotives is a colossal undertaking, and in the shadow of some of the scandals which are whispered and spoken with more or less distinc'ness concerning the steamboat inspection service, it would seem to be a dangerous undertaking.

There are the precedents of the working of the Board of Trade of Great Britain and of some of our own StateRailroad Commissions, to show how successful such agencies may be when entrusted with little other power than that of investigation and recommendation, and with the duty imposed on it of making public the evils that they discover. In the light of such experience, and in the shadow cast by public corruption, civil service inefficiency, and the prevalent malaria of selfish interests, it would seem unwise to give to any "special administrative agencies" any other power to interfere with railroad companies for the purpose of lessening the number of accidents than that of investigating and reporting on such accidents and safety appliances, with authority to recommend such as are approved.

If report speaks truly, the Interstate Commerce Commission is now overloaded, so that if any other investigations are to be made, the duty must be laid upon some other shoulders. If the investigation of railroad accidents and their causes and the efficiency of safety appliances is undertaken by the Commission, it must be done by an additional bureau ; and if in addition it is to suggest what appliances should be used to prevent accidents, the personnel of the new department should consist of technical experts. It seems as though it would be practicable to create an administrative body of this kind as an auxiliary to the present Commission, just as the Bureau of Steam Engineering and of Construction form part of the administrative mechanism of the Navy Department. An expert is placed at the head of each of these bureaus, with the requisite assistants to aid him. These departments are doubtless very much more efficient under one head than they would be if they were multicipital.

In response to the Commission's circular, our suggestion then is, that a bureau of mechanical construction and operation should be created as an auxiliary to the present Commission, and with a technical expert at its head and three assistants to correspond to the inspectors of the British Board of Trade. This bureau to have authority to investigate and report on railroad accidents, to test safety appliances, and recommend to the Commission such legislation as the investigations of the bureau may suggest is needed. This is as far as it would seem wise to go at present.

LONG LOCOMOTIVE RUNS.

In the article on the Strong locomotive, in the May number of the JOURNAL, it was stated that the run which the Strong engine made from Jersey City to Buffalo on the Erie Railroad was the longest continuous run of which we have any record, with the exception of a trip from Jersey City to Pittsburgh on the Pennsylvania Railroad some years ago. This statement, which was made from memory and without investigating the records, was, it appears, erroneous. The train, which was famous at the time as the "Jarrett & Palmer Fast Train," and which ran from Jersey City to San Francisco in 84 hours, was drawn over the Central Pacific Railroad from Ogden to Oakland, 879 miles, by a single locomotive, which, like the Strong locomotive, made stops at several points. Memory as to this run is refreshed by several correspondents, and the particulars were as follows : From Ogden westward over the Salt Lake Division, 182.7 miles, the average speed was 44.56 miles an hour ; over the Humboldt Division, 236.5 miles, the average speed was 43.55 miles ; on the Truckee Division, 204.5 miles, the average speed was 42.16 miles ; on the Sacramento Division, 119.5 miles, the average speed was 31.28 miles, and on the Western Division, 136 miles, average speed, 42.06 miles. The greatest speed attained at any point on the journey was 60 miles an hour ; the average speed for the whole distance, 36.8 miles an hour.

The engine which made this very unusual run was an ordinary eight-wheel engine, No. 149, built by the Schenectady Locomotive Works, having 16 by 24-in. cylinders and 5-ft. drivers. The weight of the engine was 65,450 lbs. ; the tank capacity was 3,700 gallons. Only the necessary stops were made—the number of them we have not at hand—and the full time was 23 hours, 59 minutes.

As before noted, while neither this run nor the run of the Strong locomotive were continuous in a certain sense, both of the engines having made stops at several points, the run made from Jersey City to Pittsburgh on the Pennsylvania Railroad was really *continuous*, the engine having gone over the entire distance without stopping, water being taken up from the track-tanks on the way.

This, of course, does not detract from the work done by the Strong engine ; it only shows that such runs *can* be made on occasion, but their rarity goes to prove that the making them is too much for the ordinary locomotive.

NEW PUBLICATIONS.

REPORTS OF RESEARCHES CONCERNING THE DESIGN AND CONSTRUCTION OF HIGH MASONRY DAMS, IN VIEW OF THE PROPOSED BUILDING OF THE QUAKER BRIDGE DAM. New York; published by the Aqueduct Commission, New York City.

Probably no single engineering structure in this country has called out more discussion or more elaborate investigation than the Quaker Bridge Dam, which is to complete the works for increasing the water-supply of the city of New York. The discussion in the first place was over the question as to whether the dam should be built or not, and when that was virtually decided a still more active discussion sprung up as to how and just where it should be built. This was natural enough when we consider that the dam will be the largest, or at any rate the highest in the world, and will take its rank among the great engineering works of America.

The Aqueduct Commission has done well in preparing and issuing the handsome book before us, and in thus putting into a form accessible to the engineering public the elaborate reports which have been made on the subject. These consist in the first place of the report by Mr. B. S. Church, Chief Engineer of the Aqueduct; then the report of Mr. A. Fteley, the Consulting Engineer, and finally the report on the plan and location of the dam made by the Board of Experts, who were called in by the Commission, these experts being Messrs. Joseph P. Davis, James J. R. Croes, and William F. Shunk. These reports are published in full; the book includes not only the text of the reports, but the elaborate tables and calculations which accompany them, and engravings of the diagrams submitted. The report thus becomes practically a treatise upon high masonry dams, for the engravings include not only plans and elevations on the Quaker Bridge Dam, but also sections of nearly all the important structures of the kind in America and Europe, which were used for purposes of illustration and comparison.

THE JOHNSON RAILROAD SIGNAL COMPANY'S CATALOGUE OF INTERLOCKING AND RAILROAD SIGNALING APPLIANCES. Rahway, N. J.; issued by the Company.

This is a very neat and convenient book of 140 pages, 8 in. × 10 in. in size, which is well printed on good paper, and with excellent engravings illustrating the mechanism manufactured by the Johnson Railroad Signal Company. It begins with a brief history of the introduction of interlocking signals in this country, and a statement of the advantages resulting from the use of such appliances. These are said to be increased safety and increased facility in handling traffic at busy points. This is supplemented with a dissertation on the essentials of good signaling, which every railroad engineer and traffic manager would do well to read, and for that reason it is quoted almost entire:

The experience of 25 years has pretty conclusively shown among other things that the Semaphore Signal is the most satisfactory type of signal; that switches and locks should be worked by pipe; that facing switches should be fitted with facing-point locks; that facing-point locks should be duplex—*i.e.*, so arranged that in the event of the breakage of connection, the plunger of the lock cannot be thrown into the wrong position of the switch; that two lines of wire should be used to each signal; that signal blades should be so constructed as to go to the danger position in case of breakage of connections anywhere between the operating lever and blade; that wires to distant signals should be automatically compensated; that iron plates should be fixed under switch points to keep the track accurately to gauge; that plungers of facing-point locks should not be pointed; that cranks and pipe compensators should be fixed on foundations firmly embedded in concrete; that all side tracks connected to main tracks should be "trapped"—*i.e.*, have a derailing switch to prevent cars coming on to the main track, until the switch is set for the side track; that a signal should be given for every train movement; that high signals should only be used for main running tracks; that separate signal-posts should be used for each track running parallel or converging; that one post with one or more blades (various systems are in use for indicating the route open) should be used for diverging tracks; that it is a most dangerous and reprehensible practice to displace or disconnect any part of safety appliances, such as detector-bar, switches, switch-locks, machine, interlocking, except in cases of absolute necessity, and then only temporarily and under proper protective conditions, such as padlocking the switches affected, issuance of caution notice, and employment of flagmen at the positions of danger; that all ground connections should be well drained and all the appliances kept clean.

This summary of good signaling requirements is followed by short notices of various inventions which have been brought out, some of which have and some have not been successful. "General instructions for operators and for the maintenance and repair of interlocking machines and work in connection therewith" are also given, with a short article on block signaling. The rest of the work is devoted to a description of the special appliances which are manufactured by the Johnson Railroad Signal Company, with complete and detail engravings of different appliances. The book is very neat, the work of printing and engravings is excellent and in good taste, and there is an entire absence of the "gay and festive" appearance which is sometimes so nauseating in a business catalogue. Railroad managers and engineers will find it difficult to pick up so much valuable information about the essentials of signaling from any other source, and in so short a time as they would be able to absorb by reading the first dozen pages of this volume, and looking over the rest of it with more or less care.

The works of this Company are at Rahway, N. J., and the New York office is at No. 146 Broadway.

THE RAPID TRANSIT CABLE COMPANY'S CABLE TRACTION SYSTEM. New York; issued by the Company.

The pamphlet before us is an illustration of the fact that much of the best technical literature now appears in trade catalogues. Many improvements in engineering and discoveries and inventions in science are never described anywhere else than in such publications. The volume before us contains a description and illustrations of the system of cable traction, which is covered by patents controlled by the Company named, and also gives comparisons of the relative merits of that kind of motive power for rapid transit roads compared with other means of propulsion. It is a pamphlet of 81 pages, and contains elaborate engravings of the structures and appliances referred to in the test. The office of the Company is at 12 Broadway, New York.

ABOUT BOOKS AND PERIODICALS.

IN accordance with the expressed wish of the late Captain John Ericsson, his biography will be written by his intimate friend, Colonel W. S. Church, Editor of the *Army and Navy Journal.* Captain Ericsson's executors have placed in Colonel Church's charge all his papers and documents which may be of use for this purpose.

A paper on the Rio San Juan de Nicaragua, by Civil Engineer R. E. Peary, U.S.N., which is published in the last number of the BULLETIN of the American Geographical Society, is a

careful description of that stream, which is to play so important a part in the construction of the Interoceanic Ship Canal, with some historical account of the part it has in previous times taken in the commerce of the world.

The May number of the JOURNAL of the Military Service Institution contains articles on a Mission for the Infantry Service, by Brevet Major-General A. V. Kautz; on Horse-Shoeing, by Major George B. Rodney; on the Practical Training of Field Batteries, by Lieutenant C. B. Satterlee, and a comparative table of the Relative Values of Field Artillery Guns, by Lieutenant A. D. Schenck. There are also a number of short articles from foreign sources, including a continuation of the very interesting letters of the different branches of the service, by the Prince Hohenlohe-Ingelfingen. The shorter notes and reviews touch on many points of interest, including the National Reserve, the Cavalry Service, Coast Defense, etc.

Among the articles in the OVERLAND MONTHLY, for May, are some Studies on Conciliation in the Labor Problem, an interesting contribution to the already voluminous literature on this subject; an account of the Oregon Indian Campaign of 1884, given under the guise of a story; while Life in Samoa, by S. S. Boynton, is a contribution to our knowledge of that little island, with which we will soon be better acquainted, by description at any rate, than with a good many portions of our own country.

The series of Railroad articles in SCRIBNER'S MAGAZINE is not yet completed. One on Safety Appliances, by Colonel H. G. Prout, and one on the Purchasing and Supply Department, by Mr. Benjamin Norton, an officer of long experience in that department, are still to appear. The June number will contain the first of the proposed series of articles on the Practical Application of Electricity. These articles will be written by experts, and are intended to give a complete statement of the present condition of Electrical Science in relation to industrial and practical life.

In the POPULAR SCIENCE MONTHLY for May, Professor C. Henderson Hall gives the second of an interesting series of articles on Glass-Making, which has special reference to that industry as carried on in Pittsburgh. Mr. Garret P. Serviss contributes an article on the Strange Markings on Mars, which are supposed to be the visible phenomena which indicate that that planet may be inhabited, and which, some astronomers have imagined, show the existence of gigantic engineering works on its surface. Among the articles in the June number will be one on the Production of Beet Sugar and also one on the Glaciers on the Pacific Coast, a subject of much interest to geologists.

In HARPER'S MAGAZINE for May, Franklin Satterthwaite writes of the effect which railroad extension and its results have had upon the wild game of the western plains and the Rocky Mountains, and of the future prospects for sportsmen in that region.

Samoa is the text for two articles in the CENTURY for May, which describe very completely that distant corner of the earth, which has been brought into prominence recently by the little international flurry of which it has been the cause. The descriptions are interesting reading. In his Siberian article, in the same number, Mr. Kennan writes with his usual force of the Trans-Baikal, to us an almost unknown region, which will become of commercial importance when the Siberian Pacific Railroad is built, since it has considerable possibilities of development, and, moreover, has on its southern border the twin cities of Kiahkta and Maimachin, through which passes the large overland commerce between Russia and China.

The ECLECTIC MAGAZINE for this month contains the usual well-selected miscellany from the foreign magazines, which is especially interesting to those who have not the facilities for reading the originals, but who desire to keep in touch with the foreign magazine literature of the day.

BOOKS RECEIVED.

A HISTORY OF THE PLANING MILL, WITH PRACTICAL SUGGESTIONS FOR THE CONSTRUCTION, CARE AND MANAGEMENT OF WOOD-WORKING MACHINERY: BY C. R. TOMPKINS, M.E. New York; John Wiley & Sons, 15 Astor Place.

SEVENTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE SECRETARY OF THE INTERIOR, 1885–86: BY J. W. POWELL, DIRECTOR. Washington, Government Printing Office.

A THEORETICAL AND PRACTICAL TREATISE ON THE STRENGTH OF BEAMS AND COLUMNS: BY ROBERT H. COUSINS, C.E., LATE ASSISTANT PROFESSOR OF MATHEMATICS AT THE VIRGINIA MILITARY INSTITUTE. New York and London; E. & F. N. Spon.

IMPROVEMENTS IN THE CONSTRUCTION OF VARIOUS TYPES OF RAILROAD CARS: BY MAX A. ZURCHER. Montreal, Canada; published by the Author.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1888. ELEVENTH NUMBER: PREPARED BY THE BUREAU OF STATISTICS, UNDER THE DIRECTION OF THE SECRETARY OF THE TREASURY. Washington; Government Printing Office. The present number contains statistics of finance, coinage, commerce, immigration, shipping, postal service, population, railroads, agriculture, etc.

RELATIVE COST OF CARLOAD AND LESS THAN CARLOAD SHIPMENTS, AND ITS BEARING UPON FREIGHT CLASSIFICATION: BY ALBERT FINK. Chicago; published by the *Railway Review*. This is a reprint of a part of the argument prepared by Commissioner Fink and submitted to the Interstate Commerce Commission, on behalf of the defendant trunk lines in the case of the complaint of Thurber and others.

THE SECURITY OF RAILWAY INVESTMENTS: BY DANIEL S. REMSEN. New York; reprinted from the proceedings of the Twelfth Annual Meeting of the New York State Bar Association.

REVISTA TECNOLOGICO INDUSTRIAL: NOS. 7 & 8, FEBRERO, 1889. Barcelona, Spain; published by the Association of Engineers.

ANALES DE LA SOCIEDAD CIENTIFICA ARGENTINA: NO. VI., 1888, and NO. I., 1889. Buenos Ayres; published by the Argentine Scientific Society.

BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: V., APRIL, 1889. Ithaca, N. Y.; published by the University.

CABLE TRACTION SYSTEMS OF THE RAPID TRANSIT CABLE COMPANY, NEW YORK. New York; issued by the Company, Cornelius Tiers, President, John H. Pendleton, Engineer.

CENTRAL EXPERIMENTAL FARM: BULLETIN NO. 4, MARCH, 1889. Ottawa, Canada; issued by the Department of Agriculture.

SIXTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK, FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1888: WILLIAM E. ROGERS, ISAAC V. BAKER, JR., MICHAEL RICKARD, COMMISSIONERS. Albany, N. Y., State Printers.

PROCEEDINGS OF THE FIFTH ANNUAL MEETING OF THE IOWA SURVEYORS' ASSOCIATION; THE FIFTH ANNUAL MEETING OF THE IOWA CIVIL ENGINEERS' SOCIETY; AND THE ORGANIZATION OF THE IOWA SOCIETY OF CIVIL ENGINEERS AND SURVEYORS: JANUARY, 1889. Glenwood, Iowa; issued by the Society. Seth Dean, Secretary.

THIRD ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF BUILDERS OF THE UNITED STATES; HELD AT PHILADELPHIA, FEBRUARY 12–14, 1889. Boston, Mass.; issued by the Association. Mr. William H. Sayward, Secretary.

CATALOGUES AND PRICE LISTS OF THE BROWN & SHARPE MANUFACTURING COMPANY; ALSO OF DARLING, BROWN & SHARPE. Providence, R. I.; issued by the Company. The reputation of these manfacturers for machine tools and also for rules, gauges, and other instruments for accurate measurement is well known.

COUNTERBALANCING LOCOMOTIVES.

To the Editor of the Railroad and Engineering Journal:

THE following article appeared in the *Railroad Gazette* of April 12 last:

Within the last year, on five different occasions, it has come to our knowledge that locomotives running at high speeds have severely injured the rails and track of five different roads. This was the result, not in every case of over-counterbalance, but rather of the attempt to counterbalance the inertia, in a horizontal direction, of the reciprocating parts. These actual facts take the action of locomotive counterbalances on rails and bridges out of the field of mere speculation. To show what may be the effect of these counterbalances at high speeds, we may state that in two cases of the five just mentioned the rails were bent vertically to such an extent as to render the track impassable at high speeds for over two miles in length, and in one case the wheel rose so far from the track in its upward gyration as to crush the wheel-guard and running-board. We have called attention to the necessity for giving much care to this subject before in these columns, and we wish to again urge all engineers who are interested in this subject, either from choice or because of their responsible connection with railroad corporations, to offer something, either in the way of design or suggestion, which will reduce the evil which already exists in the best designs, and allow locomotives to be driven at the high speeds of the immediate future without endangering the permanent way. We are not offering this as a result of speculation, hypothesis or incomplete theory, but rather as facts which are so obstinate and pertinent that two railroad companies have decided to order the removal of all that portion of the counterbalance in locomotive driving-wheels which is intended to counteract the inertia of the reciprocating parts. In order to assist in obtaining information for certain engineers of the highest standing, we propound the following question to our readers, with the hope that they will consider it a personal inquiry, directed particularly to themselves, and, as such, give it their best attention. Is it *necessary* to add to a locomotive driving-wheel counterbalance an additional weight to resist the inertia of the reciprocating parts, and thereby reduce the motions of a locomotive known as nosing, lurching, and galloping?

After much study, practice and consideration I am firmly of the opinion that it is, in the face of the facts produced that the rails were damaged in two cases out of five, so as to be unsafe at high speeds. Does this prove that it is unnecessary to counterbalance the reciprocating parts?

No! It only proves that at *high speeds* mentioned these engines over-counterbalanced. It is not stated that at slower speeds they were properly counterbalanced, but assuming that they were correct for a speed of 30 miles per hour, and over-counterbalanced for 60 miles per hour, is it any reason why we should throw away the balance for the reciprocating parts?

Before doing that, knowing the trouble it would produce, would it not be well to investigate the cause for the difference (as it surely exists) between the amount of balance required for slow and high speeds? I would say, Yes, and look for natural causes. I have been aware for a long time that such discrepancy existed, and have tried some practical experiments to discover why it was, as it seemed unnatural that it should be so.

Take, for example, 550 lbs. of reciprocating parts (on each side) on a locomotive making 336 revolutions per minute (which would be about 60 miles an hour for a 5-ft. wheel). Does it not seem ridiculous for any one to propose to bring this heavy weight from a rapid movement to a state of rest 672 times per minute without any help?

Reciprocating parts must be counterbalanced to insure safety, and *speed* is one of the most important factors in the problem, as with increased speed all relations between the propeling and resisting forces in the cylinder are greatly changed—the propeling forces being reduced while the resisting forces are increased (this, of course, refers to the link-motion engine and not to one having a constant lead, exhaust opening and closure).

No one will, I think, question that the resisting forces (back-pressure, compression and lead) are prime factors in counterbalancing an engine properly.

If this is true, is there any difficult question as to the discrepancy between a locomotive counterbalance for 30 miles or 60 miles per hour?

We design an engine for speeds of from 25 to 40 miles per hour. In doing this we aim to so proportion our ports, and the time these ports are open, as to give perfect release to escaping steam, and thereby avoid any back-pressure from this cause, until exhaust closure takes place and compression commences.

We do this correctly for speeds of about 30 miles per hour, and no fault is found with the riding of the engine; but after a time she is put on a fast train and at once reports reach you about the jumping of the engine, especially if you have any weak or springy bridges, or a portion of track that is spongy.

This is proof conclusive that the engine is over-counterbalanced for the high speed, but not for the slower ones. No alteration is made in counterbalance, but the resisting forces in the cylinder are greatly increased, the port and time are not adequate to release the escaping steam, and the back-pressure runs up from zero to say from 4 to 10 lbs. previous to the commencement of compression, which starts in with this increased pressure; this, of course, increases your resisting forces, which is equivalent to adding counterbalance, and produces the same effect as decreasing the reciprocating parts—or, in other words, makes the engine over-counterbalanced for the high rate of speed.

W.

PREVENTION OF RAILROAD ACCIDENTS.

THE following circular has been issued by the Interstate Commerce Commission, under date of May 17, addressed to all State railroad commissions and to some others who are supposed to have given especial attention to the matters involved:

The large number of accidents to employés and passengers occurring on the railroads of this country and the public belief that a great part of these might be avoided by the use of proper appliances have led many States to make the mechanical features of railroad working the subject of statutory regulation. It is well known, however, that in respect to some at least of these features, the conditions are such that regulation if attempted can neither secure adequate benefit to the public nor be just to the railroads themselves unless it be uniform over the whole country.

In view of this fact and of the request of the Railroad Commissioners of the country, as embodied in a resolution adopted at their recent convention, the Interstate Commerce Commission desires to call out as full information and discussion as possible upon the question of Federal regulation of safety appliances on railroads. The following matters seem to be of especial importance, but it is not intended to restrict the discussion to them:

1. The history in each State of safety-appliance legislation. How far such legislation has been enforced. What have been the means used to enforce it. What obstacles have been met with. What the general effect has been.

2. What is the present condition regarding automatic couplers. What prospect there is of a uniform and safe coupler coming into use. What progress the standard coupler, adopted by the Master Car-Builders' Association, is making, and what is the attitude of railroads toward it.

3. What progress there is in the use of train-brakes on freight cars. Whether such progress is satisfactory, viewed as a means of greater safety to train men. To what extent freight trains are run without the necessity of brakemen traversing the tops of cars.

4. What is being done to introduce safer methods of heating and lighting passenger cars.

5. What is the state of affairs respecting other safety devices.

6. Whether legislation looking to Federal regulation of these matters or any of them is desirable, and what the reasons are for and against such regulation.

7. What such Federal legislation, if any be desirable, should attempt to accomplish in regard to couplers; in regard to train-brakes; in regard to car heating and lighting; in regard to other matters. What its provisions should be upon each of these points.

8. If Federal legislation be expedient, what special administrative agencies, if any, should be provided to carry it out. Whether Federal inspection should be attempted, and to what extent and how. Whether a Board should be created after the analogy of the Steamboat Inspection Service. If so, how such a Board should be constituted in regard to the number and character of its members; what its powers and duties should be; what its connection with other branches of administration.

The Commission believe that justice to railroad employés and to all others concerned requires that this matter receive thorough consideration, and trusts that you will be able to give it immediate and careful attention.

UNITED STATES NAVAL PROGRESS.

The plans and specifications of the three 2,000-ton steel cruisers authorized by the last Congress have all been completed at the Navy Department. These vessels are at present officially known as Cruisers Nos. 9, 10 and 11. The limit of cost is fixed at $700,000 each. The plans are the work of the bureaus of the Navy Department, and if all expectations are realized these vessels will be the best of their class afloat.

They are to be 300 tons larger than the *Yorktown* and her class. The principal dimensions are as follows: Length on load water-line, 257 ft.; extreme breadth, 37 ft.; depth of hold to under side of spar-deck amidships, 19 ft. 6 in.; mean normal draft, 14 ft. 6 in.; displacement to load water-line, 2,000 tons; tons per inch at load water-line, 15¼; area of immersed midship section, 665 sq. ft.; transverse metacenter, 7 ft. above center of gravity. These vessels are to be twin-screw, protected cruisers with poop and forecastle decks and open-gun decks between, fitted with water-tight decks of 17½ lbs. plating at sides, reduced to 12 lbs. in the center, extending the entire length of the vessels. This deck is to be below the waterline at the sides 36 in., and all the machinery, magazines, and steering apparatus are to be below it. The rig is to be that of a two-masted schooner, bearing a small spread of canvas. The motive power for each vessel is to be furnished by two triple-expansion engines of 5,400 H. P., with cylinders of 26½, 39, and 63 in. in diameter and 33 in. stroke. The engines and boilers are to be placed in separate water-tight compartments. The crank-shafts are to be made interchangeable. All framing, bed-plates, pistons, etc., are to be of cast steel. The boilers are to be five in number, made of steel, and designed for a working pressure of 160 lbs. They are to be of the return-flue tubular type. Three are to be double-ended and two single-ended. The latter are to be used as auxiliaries, but when steaming full power they can be connected with the main engines. The vessels are to attain a speed of 18 knots under forced draft. The normal coal supply will be 200 tons, with a bunker capacity of 435 tons. The coal will be stored so as to give all possible protection to the ship.

The entire main batteries are to be composed of rapid-fire guns as follows: Two 6-in. rapid-fire breech-loading rifles, mounted on forecastle and poop decks, and eight 4-in. rapid-fire breech-loading rifles, mounted four on each broadside. The secondary batteries are each to contain two six-pounder rapid-fire guns, two three-pounder rapid-fire guns, two revolving cannons, and one Gatling gun. The torpedo outfit of each vessel will be six torpedo tubes for launching automobile torpedoes, one each at the stem and stern and two on each side. There will be a complete outfit of boat spar-torpedo gear and charges. A conning-tower, oval in shape, is to be located on the forecastle deck, being 7½ ft. athwartships by 4 ft. fore and aft, and 5 ft. 4½ in. above the deck. It is to be fitted with steam steering-wheel, engine-room telegraphs and speaking-tubes. A wooden pilot or chart-house is to be fitted forward of the conning-tower for ordinary use when not under fire. The ventilation, drainage, and electric-lighting systems are to be unusually good.

The berth accommodations and officers' quarters are to be greatly improved, and an innovation on previous arrangements made in the location of the steerage, which is to be aft of the wardroom, giving the senior officers quarters nearer amidships, which is freer from the jar of machinery and motion of the ship. Entrance to the steerage is to be effected through the after 6-in. gun supports, leaving an exclusive entrance to the wardroom for the officers quartered there, and at the same time giving spacious and more retired accommodations to the steerage.

It will be seen that these vessels are to develop 2,500 H. P. more than the *Yorktown* and nearly 500 more than the *Chicago*, with more than twice their displacement. Their speed is to be two knots faster than the *Yorktown*, equal to that of the *Charleston*, and within one knot as fast as the *Baltimore*, the *Philadelphia*, and the *San Francisco*, the great 19-knot cruisers in course of construction. The batteries of the new vessels, while not powerful enough to contend on equal terms with the great armor-clad battleships of other nations, could deliver a fire that would quickly sink any vessel not heavily armored, and, with their superior speed and manœuvring powers, they would be able to take every advantage of a slower opponent. The lines of the vessels and the disposition of their weights are such as to give them unusual stability.

The contract for the engines of the battle-ship *Texas* has been awarded to the Richmond Locomotive & Machine Works, Richmond, Va., the contract price being $634,500. The *Texas* is being built at the Norfolk Navy Yard. There are to be two screws, each driven by a separate triple-expansion engine; each engine will have cylinders 36 in., 51 in., and 78 in. in diameter and 39 in. stroke.

TRIALS OF NEW VESSELS.

The new gunboat *Petrel*, built by the Columbian Iron Works, Baltimore, had a preliminary trial trip May 9, running down Chesapeake Bay and back. On this trial she worked very successfully, reaching a speed of 17 knots with 115 revolutions, and averaged 15 knots with 110 revolutions. The Government or official trial trip was to take place about June 1.

The official sea trial of the *Charleston* took place May 9, when she ran down the coast from San Francisco to Santa Barbara, and was continued for several days. The conditions were such as to give the new cruiser a very full trial, as she had to run against a head wind and through a very heavy sea. Her behavior at sea was excellent; her speed varied from 11 to 14½ knots, no effort being made to test her in this respect, as the trial was to prove her seagoing qualities mainly. On succeeding days she is said to have run up to 17 and 18½ knots. The official report has not yet been made public.

The dimensions of the *Charleston* have already been given, but may here be repeated as a matter of interest. They are: Length over all, 320 ft.; length on load line, 300 ft.; breadth, 46 ft.; main draft, 18 ft. 6 in.; displacement, 3,730 tons. She has twin screws with compound engines of the horizontal type, which are expected to work up to 5,000 H. P. with natural draft, and to 7,650 H. P. with forced draft. The maximum speed is expected to be 19 knots an hour. The armament will consist of two 8-in. and six 6-in. rifled cannons, and 12 smaller rapid-fire guns and two Gatling guns. The ship has been built by the Union Iron Works at San Francisco.

The Secretary of the Navy has extended for four months the time allowed the Union Iron Works to complete the large cruiser *San Francisco*, now under construction at those works.

TESTS AND EXPERIMENTS.

The Secretary of the Navy has appointed a Board of Engineers to make experiments and tests of tubular, sectional, and coil boilers, for the purpose of determining the best type for adoption. Chief Engineer Loring, formerly Chief of the Bureau of Steam Engineering, is at the head of this Board, and Chief Engineer L. J. Allen is Executive Officer. The experiments will be conducted at the New York Navy Yard.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 208.*)

VII.—KRUPP'S SYSTEM.

Prussia began rifled gun-making with cast-iron muzzle-loaders; experimented with breech-loaders of the same metal, and finally settled down upon Krupp steel (1861). In the earlier constructions the forgings were procured from Krupp and assembled at Government arsenals. After 1867 the finished guns were obtained from Krupp.

In the construction of his first guns Krupp employed a single block of hammered crucible steel. Increase in size of guns and higher powder pressures soon led to the adoption of the system of built-up guns, which, with some modifications as to details, is still followed.

A Krupp gun consists of two principal parts—an interior steel tube produced from a single ingot of hammered crucible cast steel, made cylindrical from the breech to a point in front of the trunnions, and conical from thence to the muzzle. Over the cylindrical part is shrunk the jacket, which carries the trunnions and contains the breech-block aperture, and upon this are shrunk two or three rows of bands or "frettes," made from solid disks of hammered steel. For large calibers the first row of bands extends to the muzzle.

The details of construction of the larger calibers of Krupp's guns are wanting. The cut (fig. 3) is given to show the general plan followed in their construction, without attempting to give the details of the superimposed layers of hoops.

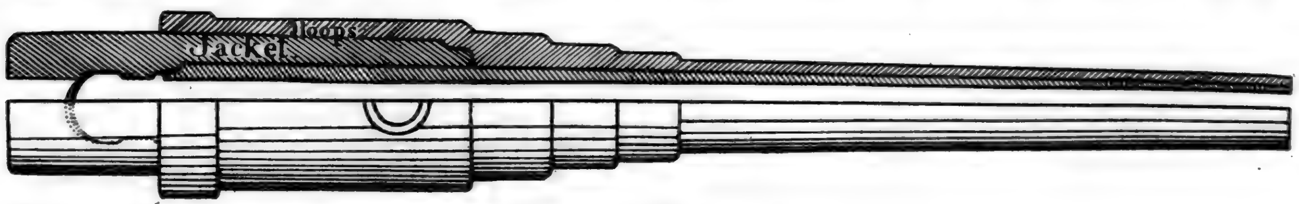


Fig. 3. Krupp Construction.

VIII.—SYSTEMS COMPARED.

In the early construction of heavy breech-loading ordnance by the English, the French, and the Germans, or Krupp, representing the three principal gun-makers of Europe, there was a wide difference both in the material used and the methods of construction. In guns of recent date, however, these differences have largely disappeared both as regards material and mode of fabrication.

In the matter of material steel alone is now used, the only question being as to the *kind* best adapted for gun construction. In the Krupp system, representing by far the largest output, as well as the ordnance of nearly all the lesser powers of Europe, crucible steel alone is employed. In England both crucible and open-hearth steel is used, with a leaning toward the latter. France uses open-hearth steel only.

In the methods of construction, or of assembling the different parts, there is no great difference. Shrinkage by heat is employed by all to bind the several parts together, except by Whitworth, who employs hydraulic pressure instead. Krupp has an inner tube of considerable thickness, a jacket and hoops; the French, a thick inner tube and hoops; the English, a comparatively thin inner tube, a thicker jacket and rings, or hoops, in two or three layers of varying lengths.

As will be seen by reference to the cuts, there is a very decided difference between the English system, on the one hand, and the French and Krupp on the other, as regards the thickness of the inner tube. In the former it is relatively thin, the superimposed hoops being depended upon to resist transverse rupture, while in the French system the tube forms practically the body of the gun. In Krupp's system the tube is thick enough to do a fair share of the work of resisting transverse strains, and in thickness is medium between that used in English and French guns.

In the matter of ordnance England has been particularly unfortunate. Beginning with wrought iron and breech-loaders, then going back to the muzzle-loader, spending 20 years in elaborating a system of these guns, of wrought iron and steel combined, and finally casting aside old models, setting to work within the last eight years to fabricate a system of all-steel breech-loaders.

But from the beginning the same general principles of construction have been followed up to a very recent date. The defects of the system have been demonstrated by so many accidents and break-downs that the only wonder is that it was persisted in so long, remembering the vast metallurgical resources and experience in metal manipulation of the English nation. The matter has been explained, and perhaps justly, by the fact that the fabrication of ordnance has been practically in the hands of the Government, represented by the Royal Gun Factory at Woolwich, to which Armstrong seems to have been a half partner. Slow-going and blindly conservative, this military close corporation has stood in the way and so effectually discouraged all private enterprise that England, which should have taken the lead in the matter of gun fabrication, has had to take second, if not third place, to say nothing of the immense sums wasted upon muzzle-loading ordnance and wrought-iron vagaries.

So numerous had been the accidents to English guns that in February, 1887, the House of Commons directed that a report be made showing the number, etc., of rifled guns in the land and naval service that had burst or become disabled in the ten years between 1875–76 and 1885–86. The report, signed by Colonel Maitland, Superintendent of the Royal Gun Factory at Woolwich, under date of January 29, 1887, shows a total of 31 guns of various calibers as having been disabled within that period. Of this number 19 were Woolwich and 12 Armstrong guns; 12 also were breech-loaders and 19 muzzle-loaders. The breech-loaders were all Armstrong except two. Out of these 31 failures, 23 were reported as having occurred to the inner tube either by cracking at various points or, as in the well-known *Collingwood* gun accident, by its being blown away entirely. It should be said, however, that but one of these guns burst explosively. This was a 12-in. 38-ton muzzle-loading Woolwich gun, of wrought iron with a steel tube. It occurred in the turret of the *Thunderer*, and was particularly disastrous. Besides serious damage to the turret and deck, 11 men men were killed and 36 wounded. A long series of experiments were made with a sister gun, which was also burst, and the conclusion reached was that the accident probably came of double-loading, but of this there never was any but circumstantial proof. It is, of course, true that none of these guns were of recent construction and none of them of all steel, yet even with the later models, the record is not altogether reassuring. We have a recent report of ten 9.2 in. Woolwich guns having failed during test. Of these, nine were from rupture of or accident to their inner tubes, and but one from fracture of the outer casing. To these may be added the failure of a 10-in. Woolwich gun during trial in January, 1888, in which case the tube ruptured half way between the trunnions and the muzzle, the front portion being blown entirely out of the casing.

The necessity for additional longitudinal strength was clearly shown in the explosion of the 100-ton Armstrong gun on board the *Duilio*, one of the monster Italian armor-clads, in March, 1880. The gun was a muzzle-

loader, and composed of a steel inner tube, surrounded by wrought-iron coils. This inner tube parted at the junction of the powder-chamber with the bore proper, and the whole breech of the gun was violently thrown back against the side of the turret with sufficient force to indent the inner skin and force open two of the outside 22-in. steel armor plates. The peculiarity of this accident was that, after striking the wall of the turret, the breech rebounded and resumed nearly its normal position on the muzzle portion of the gun, which had remained on the carriage. It might be added that, unlike the *Thunderer* accident, no loss of life resulted, two men only being burned by the escaping gas.

The accidents to the new type of English breech-loading guns led, some five years ago, to the appointment of a special committee, composed of recognized authorities on gun construction, to whom were submitted designs for strengthening guns already made, those in course of construction, and an alteration of plans of those to be made in the future. The recommendations of the committee may be summarized as follows: The hooping of all guns to the muzzle; guns under construction to have the chase formed of a double tube, or tube in two thicknesses, with the addition, in certain designated calibers, of a thin liner extending from the end of the powder-chamber to about half the length of the tube. Recent accidents would indicate that some radical fault still exists in their system of gun construction, unless it is attributed to the metal, which is hardly likely.

No system of gun construction can hope to escape without some failures, and that system may be considered the best in which the casualty list is the smallest. Judged by such a standard any comparison between the English and Krupp's system—which is one often made—can only be to the disadvantage of the former. With regard to English ordnance one may be pardoned the criticisms made upon it, in the light of the statements and protests one finds in their own journals and from English military critics.

The record of Krupp ordnance has been exceptionally good. Krupp confesses to 25 accidents to his guns in a period of 30 years, nine of them occurring since 1868. Excepting two field guns, damaged in the chase by premature explosions, these accidents were all to guns of old model. With more than 20,000 guns of various calibers fabricated and in use all over the globe, one might say, a casualty list of many times this number would still leave the record a good one.

IX.—BREECH MECHANISM.

As concerns breech mechanism there are two systems: one known as the wedge, or Krupp; the other, the interrupted screw, or French fermature.

The Krupp fermature consists of a cylindro-prismatic block, or wedge, working perpendicularly to the axis of the gun. Toward the bore of the gun this block presents a flat face, but toward the rear it is cylindrical, with a slight taper. This block slides in an opening of similar size and shape at right angles to the bore. When the breech-block is withdrawn as far as it will go—to the left—the bore of the gun is left free. When it is shoved home the breech is perfectly closed. In field guns the breech-block is moved in and out by hand. In larger calibers this is done by aid of a screw. In both cases it is driven home and locked by a second screw. Obturation is obtained by means of the Broadwell ring and gas-plate—a thin ring of steel let into a recess at the end of the bore, and against which abuts a flat plate fitted to the face of the breech-block, or wedge. Upon firing the pressure forces the ring against the plate and cuts off all escape of gas. The vent is axial and through the breech-block, and is provided with an obturating primer which prevents all escape of gas. This arrangement is shown in fig. 4.

The French system is, as stated above, of the interrupted screw pattern. The breech-screw seat is cut in the rear end of the inner tube or body of the gun and in prolongation of the bore. It has an interrupted screw thread, each alternate sixth part being planed off to correspond with similar divisions on the breech-screw. When the breech-screw is inserted, the sixth of a turn engages, of course, the three sections of screw into the corresponding threaded sections. The breech-screw is supported, when withdrawn from its seat, by a carrier-ring hinged on one side, so that it can be swung out of the way, entirely exposing the powder-chamber and bore. When shoved home it is secured by a latch-hook. The De Bange gas check is used. A stalk, secured at the rear, passes through the breech-block and has a mushroom-shaped head projecting into the bore. Around the neck of the stalk and just under the head of this mushroom is a collar of asbestos and tallow, secured in a cotton cover and supported in place by two convex tin guards. When the gun is fired the mushroom head is pressed back upon the asbestos collar and forces it against the walls of the bore. An obturating primer, as in the other system, cuts off escape of gas by the vent. This system is shown in fig. 5.

In comparing these two systems of fermature one cannot but believe that the Krupp system is by far the better one. In it the tube or body of the gun is not called upon to bear any of the longitudinal strain. The enormous backward thrust of the powder-gases is taken up by the heavy jacket and carried direct to the trunnions. The

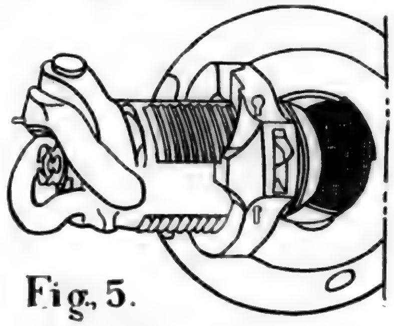


Fig. 5.

The French Fermature.

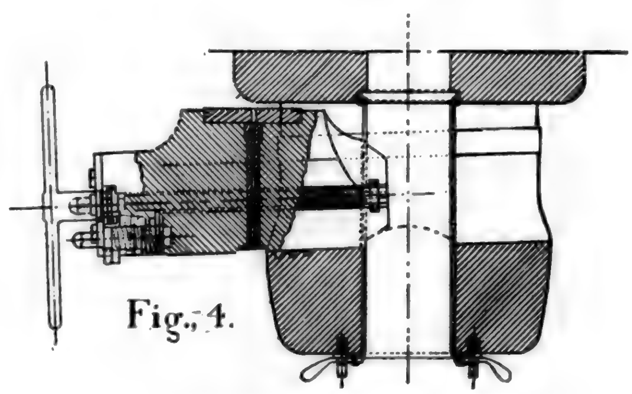


Fig. 4.

The Krupp Fermature for Heavy Guns.

mechanism is simple, and admits of the aiming of the piece before the completion of the loading.

On the other hand, in the French system the gun-tube has to bear not only the transverse but the longitudinal strain as well. The entire pressure on the breech-block must be borne by the screw-threads. That these should sometimes strip, frequently become jammed, or that rupture should here take place, is not to be wondered at. The perfect and equal contact between the screw and threaded portion of the seat, so that every part shall bear an equal strain, is next to impossible to obtain. The danger arising from imperfect locking of the breech, and the liability of the breech-block to work loose in high-angle firing, are other objections to the system. That it possesses certain advantages in the matter of manipulation over the wedge system will not be denied, but that it is as safe, possesses the endurance, or is not more liable to get out of order than the former, cannot be admitted.

A long list of accidents to French guns, extending over the past five years, could be given, showing the inherent weakness of the system. Guns have been torn apart, breech-blocks blown out, or the breech blown off in at least a score of cases, with a loss of life to gunners and

cannoneers that exceeds the famous massacre of blue-jackets by our rotten cast-iron Parrott guns at Fort Fisher. Added to a long list of previous failures of field guns, we have an account of the failure of a 34 cm. De Bange gun in August, 1887. In December last another 34-cm gun was unbreeched in the turret of the *Amiral Duperré*, while engaged in practice-firing, killing two officers and five gunners. The failure of these guns was attributed, by the advocates of the French system, to the fact that they were guns of the model of 1875. The recent failure of a *new* 34 cm. early in its trial, by the giving away of the whole breech, remains to be explained in some other way.

In England, where the French fermature, with slight modifications, has been adopted, they have been only a little less unfortunate than across the Channel. In English guns the breech-screw is seated in the jacket and not in the gun-tube, which does away with one source of weakness. An English military critic, writing in January last of the unfortunate cruise of the *Impérieuse*, says: "Two months ago her captain, William May, the crack gunner of the English Navy, was rash enough to have her 6-in. guns fired. Several locks were promptly blown out of the breech-pieces, a space having been left between them so as to allow the charge to have effect backward. The main deck battery was thus as useless as the boilers." Another writer, speaking of the same occurrence, says: "The crew having been forced to lie down to escape this modern kind of raking fire, while merely firing at a mark, is both a novel experience and a somewhat unpleasant foretaste of what might and probably would occur in action."

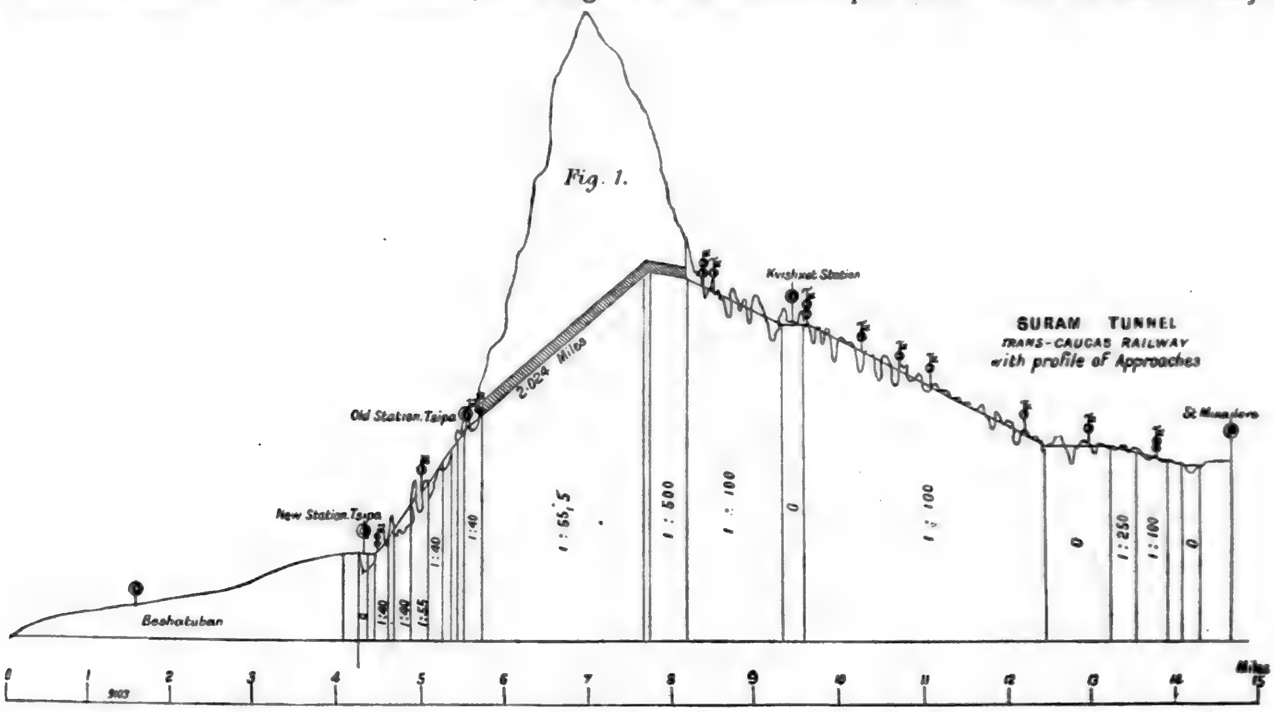
(TO BE CONTINUED.)

THE SURAM TUNNEL.

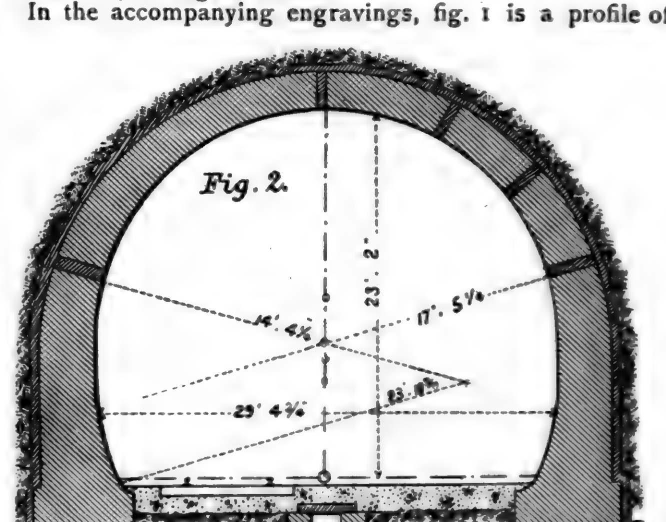
(Mr. Thomas Urquhart, in London *Engineering*.)

SINCE the Trans-Caucasus Railroad was built from Batoum to Baku, the enormous development of its traffic, owing to the discoveries of petroleum at the eastern end of the line, has made prominent the obstacle to traffic interposed by the grades of present line over the Suram Pass. Between Baku and Michailova, a station at the base of the mountain on the Asiatic side, the profile of the line presents no remarkable features, but between Michailova and Beshatuhan on the European side of the mountain and over the Suram Pass the profile rises at the rate of 4.5 per cent., with curves of 560 ft. radius for a distance of 19 versts. Thirteen trucks, being a load of 210 tons, require on this exceptional section two Fairlie locomotives, each of 65 tons adhesive weight, one engine in front, the other in rear of the train, so that hitherto the working capacity of the whole Trans-Caucasus Railroad has been obliged to be measured by the transport capacity of this short but exceptional section of the line.

When the tunnel is completed the greatest grades encountered when running west will be no more than 1 per cent., with curves of a minimum radius of 910 ft., and in running east 2.5 per cent. As it is assumed that this line will have more traffic from east to west, on account of the ever-increasing petroleum, Persian, and middle Asian export, it is considered that the still remaining grades of 2½ per cent. going east will not prove a serious obstacle, as the import trade from the Black Sea side forms but a fraction of the export trade. From the above it may safely be assumed that the capacity of the Trans-Caucasus Railroad will be materially increased, thanks to the use of the tunnel, even with the single line at present contemplated, at least by 100 per cent. The total length of the line will, on account of the tunnel and its approaches, be increased from 840 versts, Baku to Batoum, to about 849 versts, or 563 English miles.



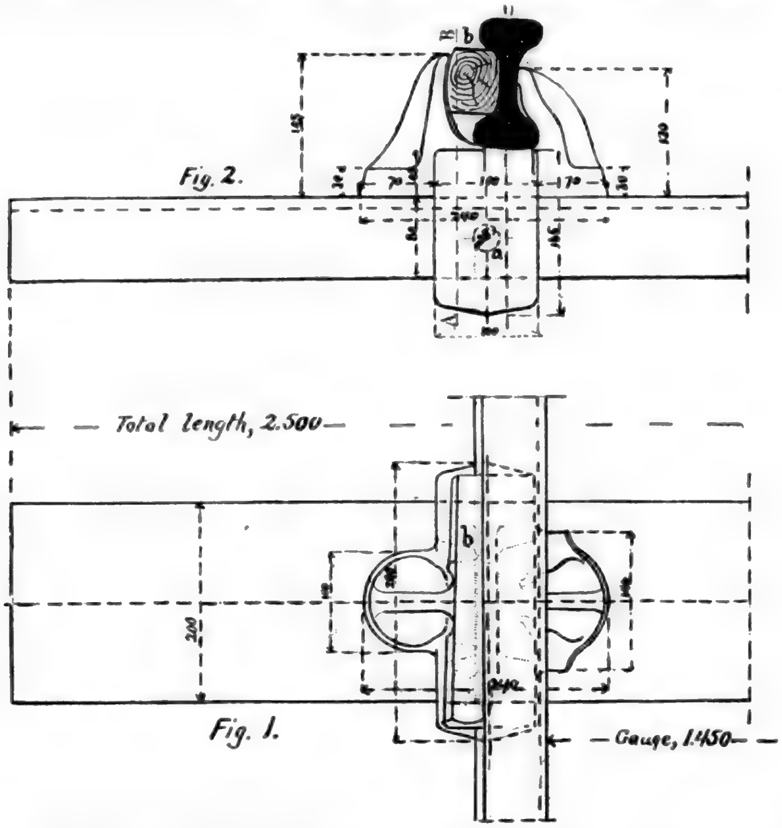
In the accompanying engravings, fig. 1 is a profile of

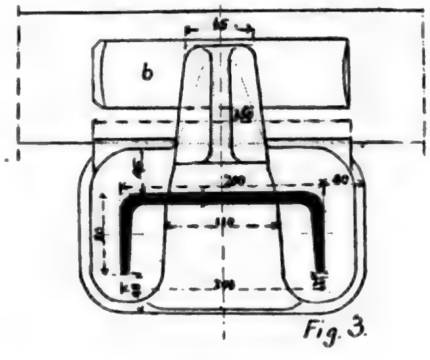


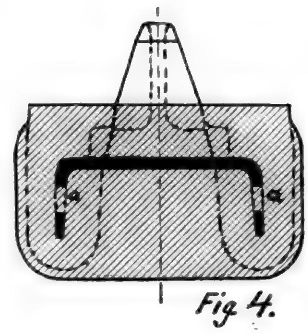
the tunnel and its approaches; fig. 2 is a cross-section of the tunnel in its finished state; figs. 3 and 4 are cross-sections of the temporary heading. It will be noticed the tunnel is intended for a double line, Russian 5 ft. gauge; the total length of tunnel is 3.73 versts, or 2.47 miles English.

The tunnel is being made by the Russian Government, and is calculated to be completed on January 1, 1890, at

an estimated cost, including approaches, of 10,000,000 roubles ($5,000,000). The work is subdivided among various contractors. The firm of Brandt & Brandan, Prussian engineers, have undertaken the piercing of a heading 8 ft. 9 in. by 8 ft. 9 in. (fig. 3) in the clear between supports, for 360 roubles per lineal sashin (7 ft.), or about $25 per lineal foot, the Government supplying all workshops, steam and hydraulic power, machine tools, rolling stock, locomotives, etc., at its own expense. A premium of 150 roubles ($75) per day is awarded to Messrs. Brandt & Brandan for each day saved in completing the heading under the contract stipulation, a mean lineal distance of 9 ft. 4 in. being considered a normal day's work for each face; the effect of this award is that the work is continuous day and night.







Profiting by the experience gained recently in the construction of tunnels in Southern Europe, the appliances now adopted at the Suram Tunnel are naturally of the most approved construction. The drilling-machines are on Brandt's hydraulic system, similar to those used at the Pfaffensprung Tunnel, St. Gothard Railroad.

There are four locomotives specially made for this tunnel by Messrs. Struve, engineers at Colomna, near Moscow; these engines are of Krauss's type, having their boilers inclined so that the tubes are level notwithstanding the incline of the rails. They are 0.90 meter gauge; two

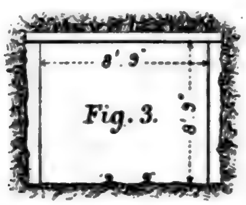
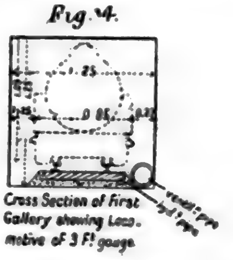


Fig. 4.



Cross Section of First Gallery showing Locomotive of 3 Ft gauge.

are 15 tons weight each, and two are 10 tons each; all are fitted with Urquhart's petroleum firing appliances. In order to obviate smoke in the workings, steam is got up to 15 atmospheres out in the open, in the exceptionally large boilers, so that no necessity arises to start a fresh fire while in the tunnel, the accumulated heat in the brickwork of the furnaces serving to keep the steam up and preventing cold air getting at the tube ends, thus preventing leakage.

The heading is driven at the bottom of the tunnel, known as the English system. The hydraulic appliances, along with Brandt's machines, are all arranged for 100 atmospheres pressure, which was the pressure used in the tunnels of the St. Gothard Railroad, but owing to the rock here being of a soft character, 30 atmospheres is sufficient; the average work done in 24 hours is 20 ft., which is much greater than the progress made in the St. Gothard tunnels. The number of holes bored in each attack is seven, of an average depth of 4 ft. 10 in., an average daily consumption of 106 lbs. of dynamite being used at each face.

METALLIC TIES IN FRANCE.

[Note by M. Clerc, Chief Engineer of the Western Railroad of France, in the *Revue Generale des Chemins de Fer*.]

THE question of metallic ties is the order of the day, and a number of systems have been tried. We may say that, in general, they have not proved satisfactory, and that only a few can support a careful examination.

It may be remarked that among the various types brought forward a few only are the invention of persons who have had experience in maintenance of way on railroads. This is explained by the fact that, while the iron and steel mills have a deep interest in the adoption of metallic ties, a majority of the engineers in railroad service—in France, at least—prefer wood, and the only reason which seems to them to justify the substitution of iron or steel is the difficulty of procuring timber for this purpose.

We cannot yet foresee the time when the scarcity of timber will compel the general adoption of metal. The price of wooden ties in France is to-day lower than for 30 years past, a fact which is explained by the greater facilities of transportation and the opening up of new districts by railroad extension. On the other hand, the life of wooden ties has been notably lengthened by the use of various processes for preserving them. We cannot yet assign a limit to the life of creosoted beech ties, although such ties have been in use already for 25 years. At the end of this long period of service such ties are found in a perfect state, and have not been replaced on account of decay—except in a few cases, where the preparation was imperfect—those which have been renewed having failed on account of splitting, cutting by chairs, or other mechanical causes.

However this may be, the question demands study, and

the object of the present paper is to present the result of trials made on the Western Railroad.

Most systems of metallic ties present the same defects—insufficient resistance to the transverse shocks which tend to spread the rails on lines where trains are run at high speed, and difficulty of obtaining a solid fastening for the rails by means of the keys, bolts, or rivets generally used. On lines of large traffic all those which have been tried in a short time show so much play, on account of the enlargement of the bolt or rivet-holes, that they have been put out of service.

In our trials we have tried to avoid these objections, and the device we have reached is shown herewith. In these illustrations fig. 1 is a half plan of the tie; fig. 2 a half elevation; fig. 3 is a cross-section; fig. 4 is another cross-section, on the line *A B*, fig. 2. The arrangement is for the double-headed pattern of rail, with chairs, which is generally used on our lines; but it could easily be adapted for a rail of the Vignoles pattern.

The tie itself is a bar of steel of inverted ∩ shape, 0.20 meter (7.87 in.) in width, 0.08 meter (3.15 in.) in height and 2.50 meters (8 ft. 2.5 in.) in length. The gauge of the road is 4 ft. 8½ in. At the proper points there are cast on the tie itself chairs of cast iron which are prolonged below in such a way that they entirely surround the steel bar for a distance of 0.10 meter (3.93 in.). The chairs thus cast are fixed solidly on the tie by the shrinkage of the iron and, to prevent any working loose in service, holes are drilled in the tie as shown at *a a a*, figs. 2 and 4, or else the tie is serrated at the bottom. The holes are filled with cast iron, forming a pin solid with the chair, so that any movement is impossible.

In this way a tie is obtained forming practically one piece with the chairs, and without those movable pieces or attachments which form so serious an objection. The rail is fastened in the chair by the wooden key or wedge *b b b*, figs. 1, 2, and 3.

The resistance of this tie to transverse movement is considerable. The cross-section of the tie and the mass of cast iron which accompanies it is $0.280 \times 0.165 = 0.0462$ square meter for each chair, and consequently its bearing surface on the ballast, to resist lateral movement of the track, is twice that, less the sectional area of the track, that is:

$$2 \times 0.0462 - 0.00275 = 0.08965 \text{ sq. m.}$$

With an ordinary metallic tie this bearing surface, counting that presented by the base of an ordinary chair, and taking the same sectional area for the tie, would be only:

$$\frac{0.00275}{2} \times 0.05 \times 0.10 = 0.01275 \text{ sq. m.}$$

With a wooden tie, under the same conditions, this bearing surface would be:

$$0.22 \times 0.14 + 2 \times 0.05 \times 0.10 = 0.408 \text{ sq. m.}$$

These figures show that the section by which the tie in question bears against the ballast, to oppose lateral movement of the track, is about seven times as great as that of ordinary metallic ties and more than twice that of a wooden tie.

We must also remark that, in consequence of the arrangement of the mass of iron which surrounds the tie, the rail is supported for the whole length of this piece of iron—about 0.25 meter—instead of being carried for 0.10 meter only, which is the width of an ordinary chair. The surface by which the rail is supported is thus about 2½ times as great with this tie. This presents the advantages of reducing the distance between the bearings, of producing a more complete support, and of diminishing the gaps which tend constantly to arise between the rail and the chair. These advantages seem to have a certain importance.

The weight of a tie of this kind is about 110 kilogs. (242.5 lbs.), of which the steel tie forms 60 kilogs. and the cast iron 50 kilogs. The price at present is 14 francs ($2.73) each, the steel bar costing 9 francs and the cast iron chairs 5 francs. This price is no greater than that of most of the metallic ties proposed, considering that it is ready to receive the rail without any additional supports or fastenings.

The Western Railroad Company, after trying ties of this type for two years on sections of the road where the traffic is heaviest, has just ordered 5,000 more of the same kind, with some slight modifications in detail, suggested by experience, and intends to continue the test on a large scale.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page 222.*)

CHAPTER XLVIII.

THE HYDRAULIC FORGING PRESS.

Before making a comparison between the hammer and the hydraulic press, we must first give some description of this last apparatus. The Hydraulic Press is generally composed of three parts.

1. The compressing pumps.
2. One or several accumulators.
3. The receiver or body of the press, properly so called.

The compressing pumps transform into hydraulic energy a certain volume of water per second, under a determined pressure; their duty is regulated by the volume of water per second used by the apparatus which they supply. The pressure of water can be increased without changing the duty, as it is sufficient for that purpose to increase the speed of the pump. In the same way we can increase the duty while maintaining a constant pressure.

In order to secure the best working of the pump, the water should reach it at a light pressure; in this way all the trouble due to drawing in air at a certain depth is avoided.

The work done by a hydraulic receiver varies with a volume of water used and with the pressure.

The loss of the total charge required to fill the admission passage as well as that of the return passage are both proportional to their length, and inversely proportional to the section of the pipe. In order, then, to reduce this loss to a minimum we must make the passages as short as possible, especially that of pressure, reduce the volume of water used, and make the pipes of the largest possible section. The joints of the pressure conduit must be made with carefully fitted and packed flanges and with the greatest care; those of the return passage where the pressure does not generally exceed 10 kilogs. may be made like those of ordinary water-pipes.

Two sorts of accumulators are used.

1. The ordinary accumulator of large diameter, for cases where large quantities of water and light pressure are necessary.
2. The differential (Tweddell) accumulator in cases where a small volume of water and a very high pressure are employed.

The accumulator consists of a plunger-piston, loaded with a certain weight and moving in a cylinder, inside of which the water is brought up to the pressure of the accumulated charge on the piston.

The accumulator is especially advantageous when the work is intermittent, as happens with many tools in workshops, such as shears, punching machines, riveting machines, and forging presses; but its use is not of any advantage where the work is continuous.

CHAPTER XLIX.

THE HASWELL PRESS.

The forging of iron and steel by hydraulic pressure was used for the first time, at Vienna, by M. Haswell, Director of the shops of the Austrian State Railroad.

In 1862, at the London Exposition, drawings of the hydraulic press which he used were shown. In this apparatus the pumps forced the water directly to the piston of the press, and they were worked by a very large steam piston, the distribution of the steam being regulated by a jet-valve. This press was used to forge axle-boxes, cross-

heads, and similar pieces, and also the detached pieces of locomotives and tender wheels; it was also used for drawing out ingots of iron and steel.

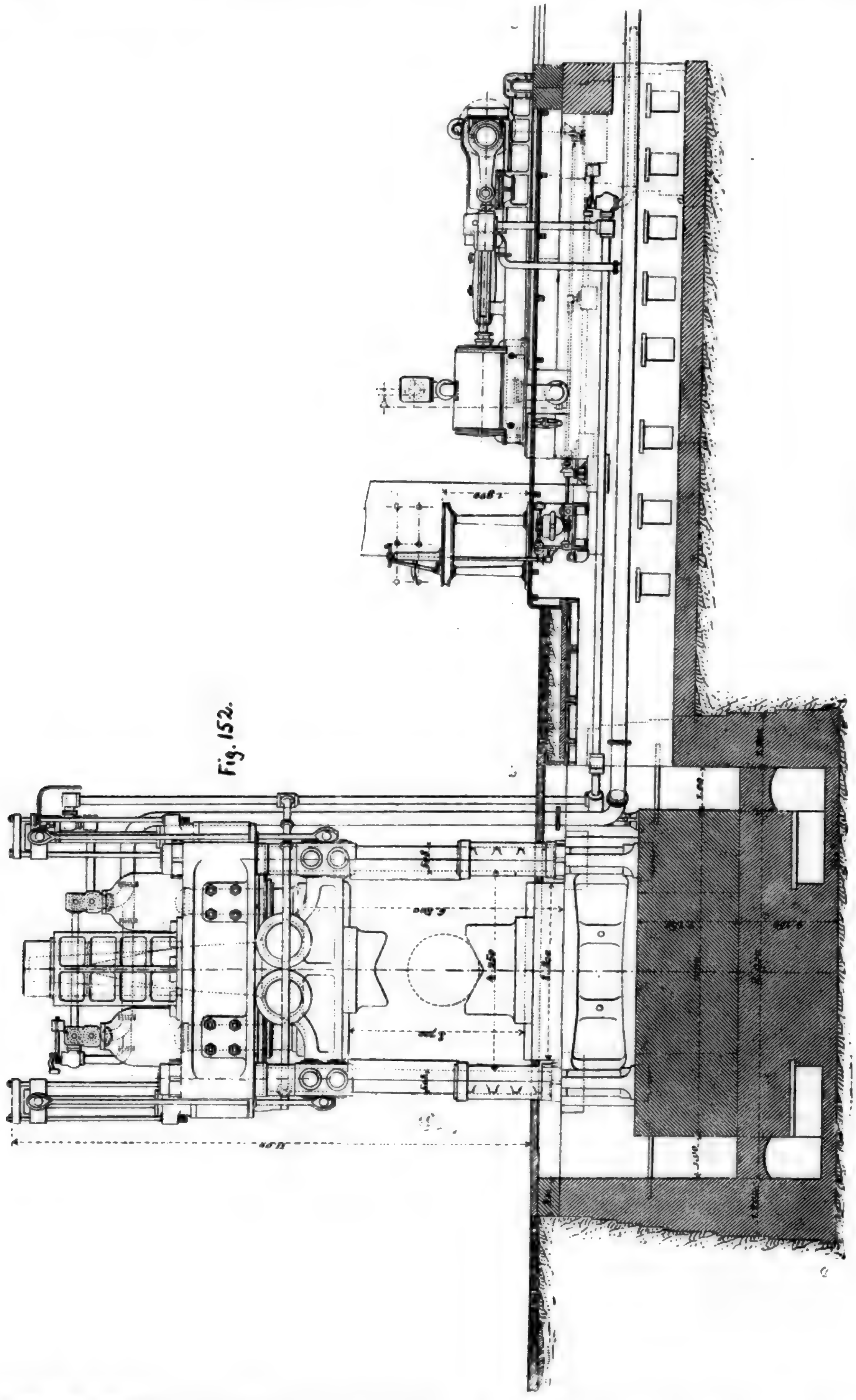


Fig. 152.

THE DAVY HYDRAULIC FORGING PRESS.

In 1873 MM. [de] Dietrich & Company had erected in their shops at Reichsoffen a Haswell press, the power of which was 1,500 tons. Borsig, at Berlin, and Krupp, at Essen, had also installed in their shops similar presses to be used for the same work.

The use of the Haswell press has not become very general. It is only within a short time that certain construc-

tors like Whitworth and Davy Brothers, at Sheffield, and Higginson, at Liverpool, have improved this tool. They have not hesitated to apply it to the forging of artillery material and to all pieces where uniform quality is required

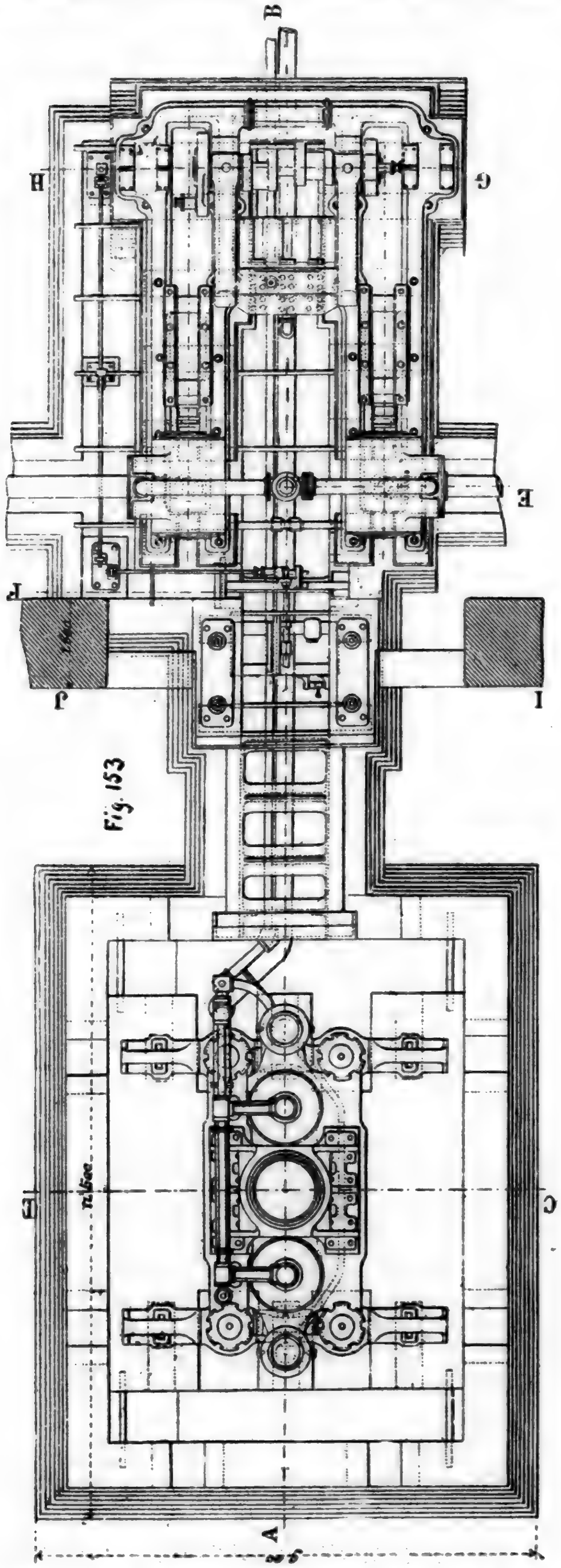


Fig. 153

and which must be worked sometimes at as low a temperature as a dull red. They have also substituted a progressive and continuous pressure of the hydraulic press, for the violent shocks of the steam hammer, and in this way have reduced very much the slow and costly construction which characterize those tools, in this way making a very important improvement.

CHAPTER I.

THE DAVY PRESS.

This press, which is represented in figs. 152, 153, 154, 155, 156, and 157, was built by Davy Brothers, in Sheffield, England, for the shops of Cammell & Company of the same city, from the designs of Mr. Charles Davy, who has taken out patents in all the States of Europe and the United States.

This press is composed of two large pistons, each 0.915 meter in diameter and 2.820 meters stroke, separate from each other, and of two relieving pistons 0.230 meter in diameter and 2.135 meters stroke. The press cylinders are carried by a solid frame or table resting upon two girders, each 1.515 meters in depth, joined by two shorter girders forming cross-braces. A similar but heavier plate or table forms the base of the press, which is united to the frame by four large bolts, or columns of steel, 0.508 meter in diameter; the distance from the base to the supporting frame is 6.400 meters and the columns are 4.570 meters between centers in one direction and 1.930 meters in the other.

The movable part—carrier or hammer-head—has the form of a T; it is guided at the end by slides fastened to the column and above by a long rod working in a hollow column bolted to the upper frame. The slides below are in two pieces fastened together by keys, sufficient play being allowed for expansion when the columns are heated by radiation from the piece to be forged.

For the same reason—the necessity for allowing for expansion—it is evidently impossible to attach the piston-rods rigidly to the head, and so these rods are made with spherical ends, which simply rest on the head. It will be seen in this way that the head is kept in an upright position entirely by the guides and the hollow column above, and that the lateral pressure on the columns is hardly appreciable. It is hoped, therefore, that all these parts and also the leather packing of the pistons will last for a long time.

This system adopted by Mr. Davy, of guiding the head independently of the pistons, permits the forging to be placed on the anvil-block wherever convenient, even if it is not exactly in a central position, without the fear of breaking the piston.

The substitution of two presses, or cylinders, for the single one previously employed possesses other distinctive advantages and increases its usefulness and security. The girders forming the upper frame are comparatively light, weighing about 28 tons each. The distance from the axis of the columns to the axis of the body of the press is only 0.876 meter. The principle being thus admitted of reducing the extreme width of the frame to the smallest possible dimension, the chains which hold the forging can be placed at a very short distance from the anvil if necessary.

The hydraulic power is furnished by three single-acting pumps, each 0.152 meter diameter and 0.305 stroke, driven by a shaft with three cranks, which is attached to a steam engine with two cylinders, each of 0.865 meter diameter. These pumps are fed by a column of water in which the pressure is 4.600 kilogs. per square centimeter, in such a way that very light admission valves are necessary, and the advantages are little play and very slight repairs. The use of water at a low pressure is best for the press itself; it is required to secure the rapidity of action which is so desirable and to prevent the infiltration of air into the passages and cylinders.

The hydraulic pressure is 330 kilogs. per square centimeter at the level of the pumps, and depends on the resistance of the forging to compression.

The capacity of the pump is such that at each revolution the hammer-head descends 0.012 meter, but it raises itself 0.200 at each revolution, the areas of the relieving piston and of the forging piston having a ratio of 1:16.

The pumps can work up to 60 revolutions per minute and even higher, so that the descent and relief of the piston can be effected at a considerable speed.

Although the forging pistons work rapidly under the action of the pump, they are still not quick enough to give a certain play between the upper head and the forging when the latter is turned into a new position. If we sup-

pose a simple round shaft placed under the press the head must be raised after each operation at least 0.150 meter above the forging, to permit it to be turned. This play is obtained with a speed of 0.610 meter per second by putting the small or relieving piston into communication by means of large valves with the low pressure. Without describing in detail the arrangement of the valves and of the tubes for high and low pressure, which are shown clearly in the illustration, the action of the press will be easily understood. When it is necessary to raise the head some centimeters above the piece to be forged the escape valve of the relieving pistons is first opened. The forging piston being at this moment opened to the low pressure the head descends rapidly until it rests on the forging. The pumps are then put in motion, the large valves of the forging pistons are closed automatically, cutting off the connection with the column of water at low pressure and opening it with that at high pressure. As soon as the required compression has been effected the head is raised rapidly for another blow. Two levers only are necessary to control the three motions, one for the press itself and the other to start the pumps.

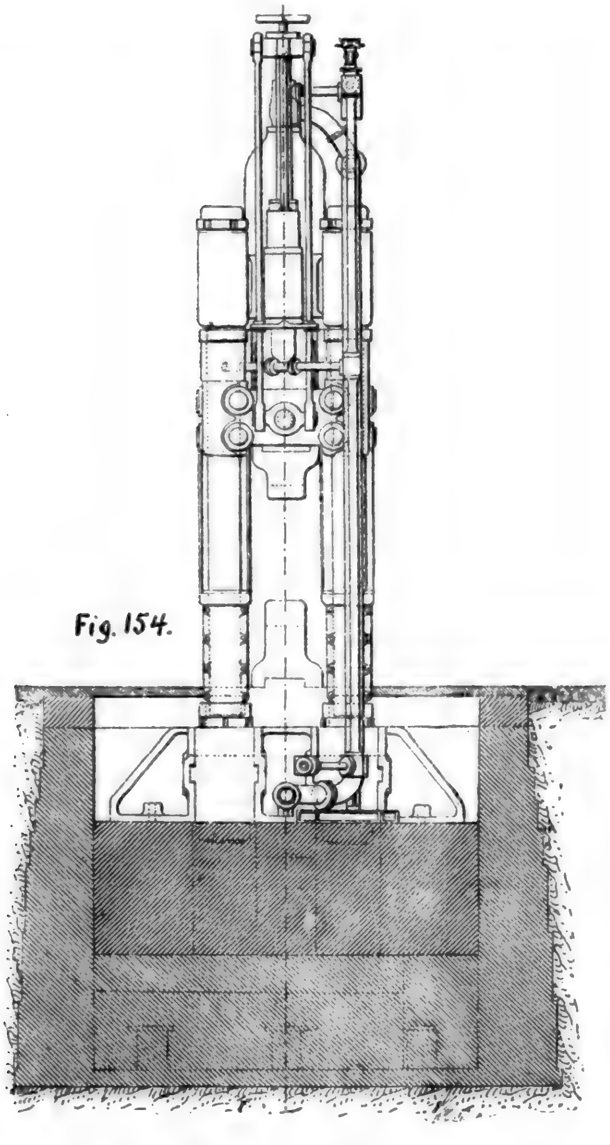


Fig. 154.

By following this method of operation the position of the head is regulated automatically whatever may be the thickness of the forging.

The working of this press is as easy as that of a steam hammer, because a forging having a rectangular section can be pressed alternately on the flat and on the edge without the necessity of moving it to the center of the anvil.

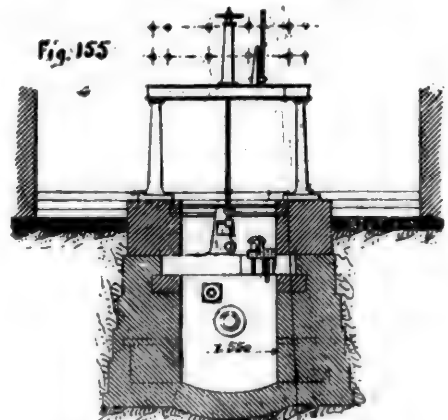
The forge built by Cammell & Company is a brick building 78 by 18 meters, with two wings covering the furnaces. The press is in the center of the building, one furnace being placed at each side. Two overhead cranes, one of 110 tons and one of 150 tons, serve the press and both the furnaces. The whole plant was furnished by Davy Brothers, of Sheffield.

We close this description by saying that the girders forming the upper frame, the lower frame, and the base of the press are of cast steel, and the columns are of forged steel made in the shop itself by Cammell & Company.

CHAPTER LI.

THE HIGGINSON PRESS.

Mr. Higginson of Liverpool, England, makes a forging press which he calls a hydraulic hammer and in which he has dispensed with the accumulator, which is heavy, costly, and inconvenient. He has replaced it simply by a heavy fly-wheel on the shaft driving the pumps, which fulfils the part heretofore intrusted to the accumulator. The different pressures required by the different kinds of work are regulated by safety valves, in such a way as to be always a little below the maximum attainable. When the press is not at work the pumps simply cause water to circulate through the passages. When the water is admitted to the piston the part of the stroke in which it has no work to do is accomplished by water at a pressure only a little above the ordinary circulating pressure; but when the piston meets with resistance the pressure is rapidly raised and the work is done at the expense of the power stored up in the heavy fly-wheel.

Fig. 155


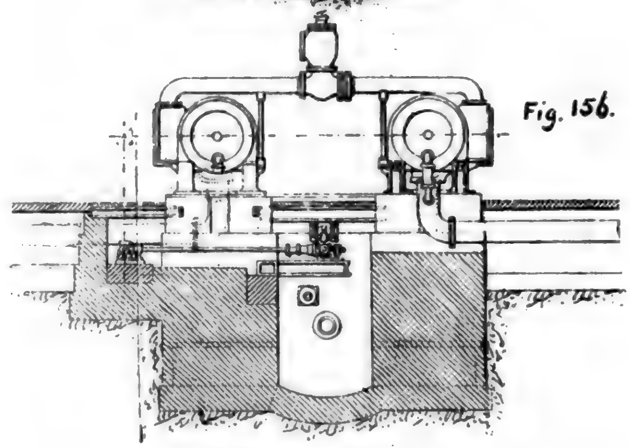


Fig. 156.

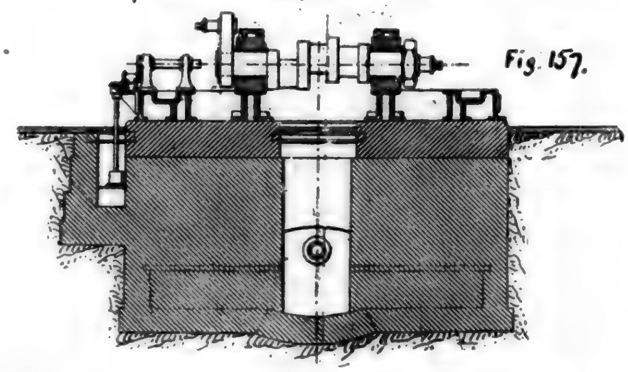


Fig. 157.

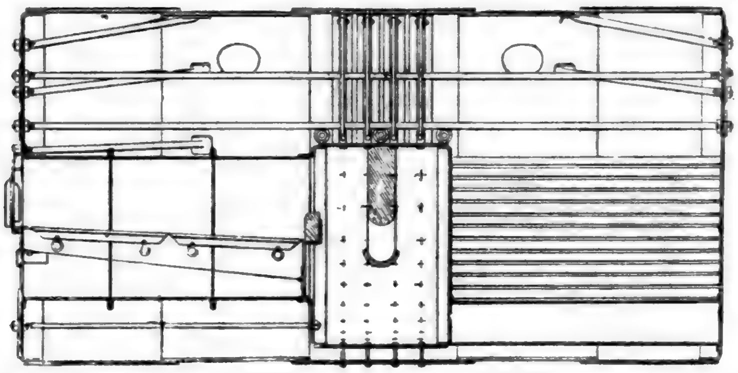
So far only three sizes of these forging presses have been built; these have a power of 50, 100, and 150 tons, which, according to the builder, are equivalent respectively to hammers of 500, 750, and 1,000 kilogs. These presses can give from 20 to 40 blows per minute according to the work to be done.

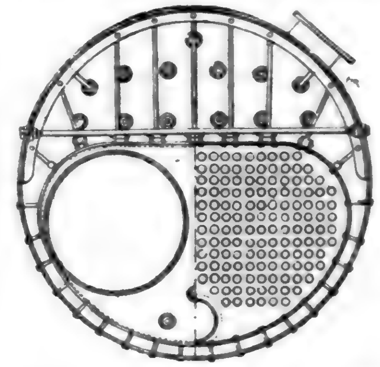
(TO BE CONTINUED.)

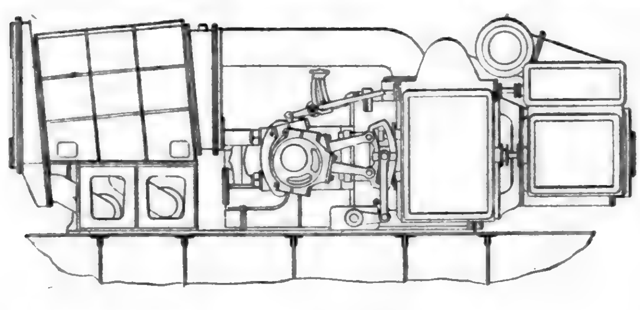
THE ESCAPE OF THE "CALLIOPE."

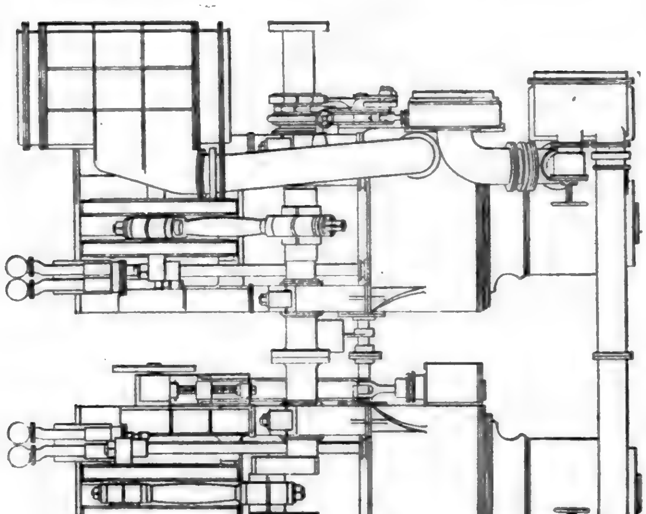
(From the London *Engineer*.)

THE sensational escape of the British ship *Calliope* from Apia Harbor, Samoa, deserves to be placed on record in our pages, as it was, in one sense, wholly due to the excel-









lence and sufficiency of her machinery. In it her captain placed implicit confidence, and his confidence was not misplaced, the *Calliope* being literally forced by her engines in the teeth of a tornado. For some time she did not make half a knot an hour, but she held her own, and ultimately steam and iron beat wind and water, much to the credit of English engineers, who, it is fair to say, have taught the technically-educated German one more lesson. The *Calliope* was built at Portsmouth dockyard in 1883; she is of a class slightly larger than the original "C" class, as an improvement on that class; her length is 235 ft.; beam, 44 ft. 6 in.; with a displacement of 2,770 tons, and a larger proportion of engine power to displacement than vessels of that class, her machinery being of 3,000 H. P. in place of 2,300 H. P., with natural draft, to which was added an arrangement for moderate forced draft after the completion of the trials of the engines. The engines were made by Messrs. J. & G. Rennie, of Blackfriars, London; are of the horizontal double piston-rod tandem description, with four cylinders, the high-pressure cylinders being of 42-in. diameter and the low-pressure, of 72-in. diameter, with a stroke of 36 in., making about 90 revolutions per minute, at full power with natural draft. The boilers, six in number, are of the ordinary horizontal type, the tubes being in a line with the furnaces, placed in two groups of three boilers, each boiler being 18 ft. 3 in. long by 9 ft. 2 in. diameter, with a total heating surface of 9,254 square feet, and grate surface of 301 square feet; working steam pressure, 90 lbs. The surface condensers are entirely of gun-metal, with a condensing surface of 6,000 square feet.

The engines were made originally very strong throughout, with the view of the addition of increased power by forced draft, and the screw was made on the feathering principle. The engines of the *Calypso*, a sister vessel, were also made by Messrs. J. & G. Rennie.

We give also two sections of one of the boilers, which are of a type much used in the Navy when it is necessary to keep down weight. These boilers have proved efficient, and steam well when properly handled.

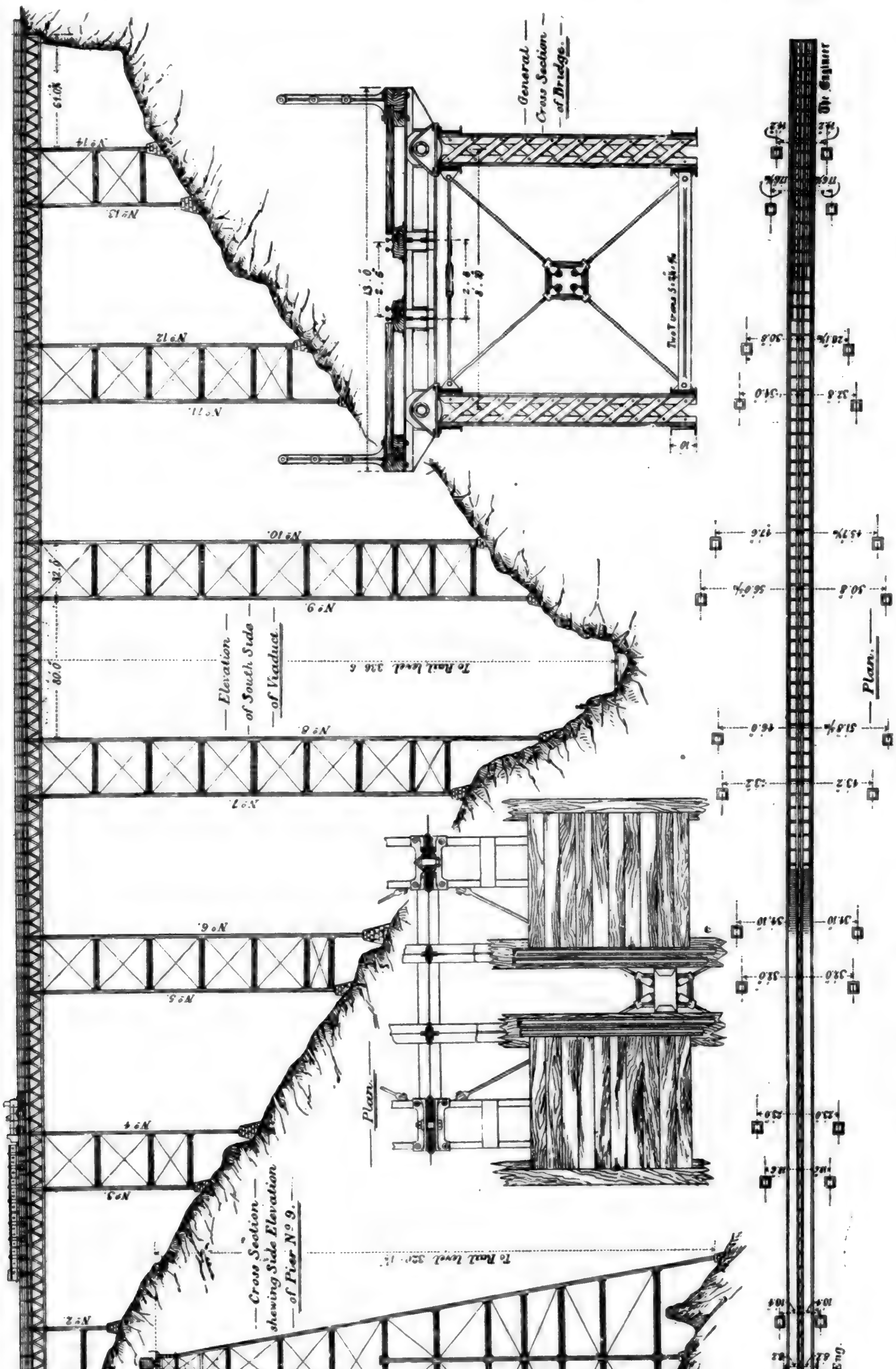
THE HIGHEST VIADUCT IN THE WORLD.

(From the London *Engineer*.)

THE accompanying illustration gives a plan and elevation, with cross-sections on a larger scale, of the viaduct over the River Loa on the Antofogasta Railroad in Bolivia, which, it is claimed, is the highest railroad bridge in the world.

The cañon spanned by the Loa Viaduct is situated in the upper Andes, at an altitude of 10,000 ft. above sea-level. It has been formed through solid rock, probably by the joint influence of volcanic action and ice-flows. Its sides are precipitous and rugged, and great difficulty was experienced in selecting a practicable point of crossing for the railroad. Some idea of the character of the ground may be formed from the fact that it was considered very good work for any of the surveying party to cross the cañon in two hours. There is no available path up the cañon; consequently all materials used in the construction of the viaduct had to be delivered on the seaward abutment, and the whole of the ironwork for the piers had to be lowered into the gorge.

The work of locating the railroad and selecting the point of crossing was undertaken by Mr. Josiah Harding, who was at that time the Engineer of the railroad in Bolivia. To Mr. Harding is also due the credit of proposing the



VIADUCT OVER THE RIVER LOA, ANTOFOGASTA RAILROAD, BOLIVIA.

general character of the structure, and fixing the positions of the piers.

After the main features of the proposed viaduct had been submitted by Mr. Harding to Mr. Woods, and approved by him as Consulting Engineer to the railroad company, Mr. Harding returned to Bolivia, and took charge of the necessary masonry work for the foundations of the piers and the abutments. This work was executed in anticipation of the arrival of the ironwork from England, and it is satisfactory to know that when the viaduct was erected there was not the slightest adjustment required in the foundations or the ironwork.

After approval of the general character of the proposed viaduct, Mr. Woods undertook the responsibility of making the necessary calculations and designing the details, a work of no small magnitude.

In the absence of trustworthy data as to the force of the wind during hurricanes, which sometimes occur of considerable violence, blowing up the cañon, it was decided in making the calculations as to stability to take the maximum possible wind-pressure at such an intensity as would be sufficient to blow a train of empty trucks off the viaduct, the condition of least stability being when the viaduct is loaded with an empty train. This pressure was carefully computed, and the result obtained adopted in the subsequent calculations for stability. Supposing such a pressure had at any time to be withstood by the viaduct—which is very improbable—there would then be a large margin of stability. It should be remembered in connection with the question of wind-pressure, that the weight of the atmosphere, at the great altitude at which this viaduct is erected, is only about two-thirds of that at sea-level, the barometer standing at about 21 in. of mercury.

The following are some of the principal particulars of the viaduct:

Length between abutments	800 ft. 0 in.
Height from water to rail level	336 ft. 6 in.
Length of longest column	314 ft. 2 in.
Length of principal spans	80 ft. 0 in.
Length of pier spans	32 ft. 0 in.
Width of platform over all	13 ft. 0 in.
Width, center to center, main girders	8 ft. 10 in.
Depth of main girders, centers of booms	7 ft. 11 in.
Batter of outer columns	1 in 6
Batter of piers	1 in 3
Gauge of railroad	2 ft. 6 in.
Weight of ironwork	1,115 tons.
Rolling load per foot	1¼ tons.

The viaduct was erected without any temporary staging, this being effected in the following manner: A wire-rope tramway was constructed across the cañon, consisting of two of Messrs. John Fowler & Company's strongest steel plowing ropes spanning the gorge from side to side, being a clear span of 800 ft. And on this aerial road a carrying truck was hauled backward and forward by steam winches placed upon the abutments; all the parts of the piers were launched on this tramway, and when over the places where they were required, were lowered by suitable tackle. The piers are constructed in stages, so that as each tier was completed a working platform was formed for the construction of the next.

It may be interesting to mention that after the wire ropes were in place, it was decided to send a locomotive and a large quantity of the material required for the construction of the railroad across the cañon by the means they afforded, and this was safely accomplished. The locomotive was taken to pieces, but the weight of its boiler being much in excess of any part of the viaduct, the ropes were strained very heavily by its transit. However, they withstood this exceptional trial most satisfactorily.

As the piers were completed, the girders forming the superstructure were placed in position by means of a crane, sent out with the ironwork from England, and constructed to lift the longest girders—80 ft. span—in one piece and place them in position. This crane was worked by hand and made to run on a special line of rails, laid immediately over the girders which were in place; it had an overhang of jib of 50 ft., and was tested with a load of 12 tons, the weight of each of the main girders being slightly under 10 tons. The girders were put together on the abutment and riveted up complete, and were then placed in position by the aid of the crane in a very few hours. In the construction of the main girders channel irons were very extensively used, which for small spans is found to be very economical, on account of the small quantity of riveting entailed. The cross-girders and rail-bearers are of iron, the former resting on turned steel pins, carried by steel castings on saddles, bridging the top boom of the main girders. Provision was made at one end of each main girder for expansion and contraction, as also in the wrought-iron rail bearers. One of the spans of each class was very severely tested before leaving England, and the results obtained were remarkably good. The section of the columns consists of four rolled pillar iron sections, and four bars of 3½ in. × ¾ in. The method of joining the columns is very simple, and has been found to be most effective. It consists of an internal diaphragm of cruciform section, built up of three plates and four angle irons. These junction pieces were sent out riveted in place at the upper end of each column, thus forming a base or spigot for the following length of column to be placed upon or over.

The diaphragm junction pieces are each 4 ft. 8 in. long, the plates used in their construction being ¾ in. thick. The 3½ in. × ¾ bars are stopped at 2 ft. 4 in. from either end of each column, and the spaces between the flanges of the pillar irons, for this length, are occupied by the plates of the cruciform junctions, which plates are extended beyond the width of the column where necessary, and thus form wings or lugs, to which the main bracing of the pier is attached. All the tie-bars, excepting the horizontal ones, are in pairs, and this was found to give much facility for the erectors to get about the work. All tie-bars are fitted with muff coupling boxes, so that they can be adjusted to the exact length required. It was a condition of the contract that a special hydraulic press should be provided by the contractors, capable of testing a length of column of 30 ft. 6 in. to destruction.

The results obtained from the tests made on two columns were remarkably satisfactory and uniform, there being practically no difference between the two. In one case the pressure was applied direct to the column section, and in the other to the junction diaphragm. In this latter case it was arranged that the whole of the pressure was conveyed to the column through the rivets connecting the diaphragm at one end, and transmitted through the bolts connecting the diaphragm at the other, the object being to prove the sufficiency of the connections. The general results obtained were as follows: With a load of 600 tons, no measurable permanent distortion was obtained; with a load of 625 tons, a slight permanent deflection from the straight line resulted; and with a load of 650 tons, the column was crippled. The gross section of the columns tested was:

	Sq. in.
Four pillar irons, each 7.5 square inches	30.0
Four bars, 3½ × ¾	10.5
Total gross section	40.5

It will thus be seen that these columns withstood, without permanent distortion, a stress of 14.8 tons per square inch of gross section; a remarkable result, seeing that the greatest diameter of the column—measured over the flanges—is one-eighth of its length. After the two columns were tested as above described, they were further subjected to a falling weight test to prove the resisting power of the material to sudden impact.

The contract for the viaduct was secured by the Horseley Company, of Tipton, Staffordshire, and the firm executed the work to Mr. Woods's entire satisfaction, the materials employed, all of which had to stand most severe tests, and the quality of the workmanship throughout being of the highest class. Each pier was temporarily put together and laid upon a level platform in the bridge-yard, with all cross-bracing, struts and ties in place, and then carefully checked as to dimensions. The Horseley Company undertook to send two skilled men out to Bolivia to superintend the erection, and their choice fell upon Mr.

Peter Fisher, as principal, and Mr. William Fisher, his brother, as assistant. How carefully the work had been executed here, and how good a choice the contractors made in their representatives, is shown by the following facts.

Before the work of erecting was commenced Mr. Harding had given up his position in Bolivia, and Mr. Peter Fisher had therefore to take the responsibility of the erection. He commenced rigging up tackle in Bolivia on May 2, 1887, the viaduct was finished on January 28 following, and the first train was run across on February 16, 1888. The above result was accomplished without the assistance of any skilled labor, as the only men available were such as could be picked up at the port of Antofogasta. They were mostly sailors, without any previous knowledge of iron construction. Not only was the viaduct erected within the comparatively short time of rather over nine months, but it is a satisfaction to all concerned that it was completed without loss of life or serious accident. The number of men employed upon the work averaged 35 to 40, the greatest number at any one time being 55. Trains run over the viaduct at speeds of about 30 miles per hour as a maximum.

HYDRAULIC ENGINE FOR LOADING GUNS.

(From the London *Engineer*.)

THE *Edinburgh*, one of the later ships of the English Navy, is a first-class twin-screw turret battle-ship, with armored citadel, but with ends unprotected except by a steel deck covering the magazines, engines, and other vitals.

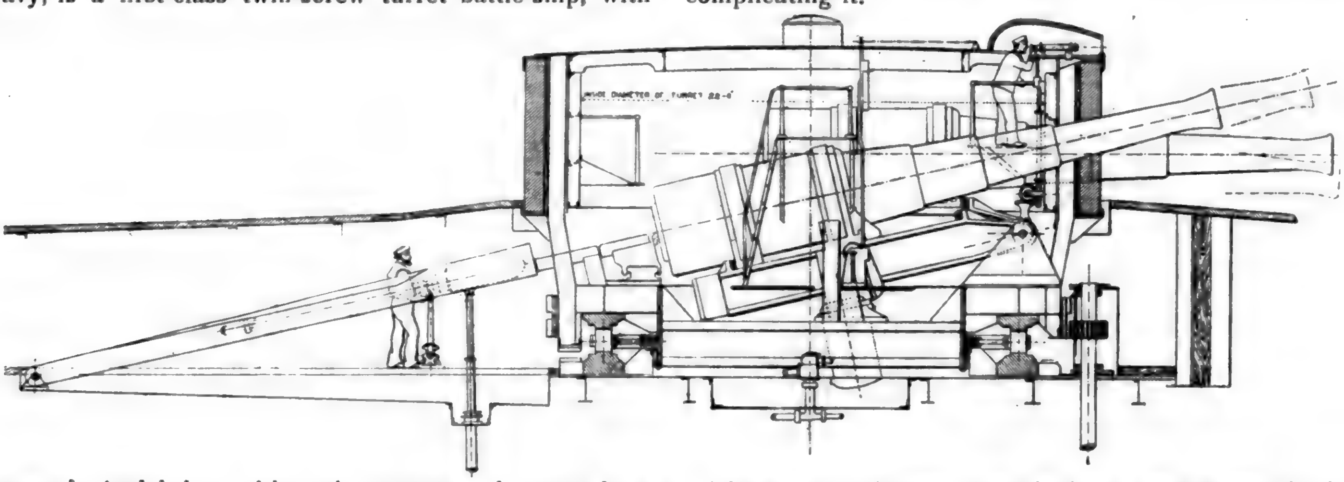
This ship and the *Colossus* are precisely similar, the principal dimensions and other characteristics being as follows: Length, 325 ft.; beam, 68 ft.; extreme draft, 26 ft. 3 in.; displacement, 9,150 tons; both were completed in 1886; the engines of the *Edinburgh* were turned out by Humphreys, those of the *Colossus* by Maudslay; indicated H. P., 7,500; speed, as tested on measured mile, 16 knots. The cost of the hull and machinery was about £645,000 in each case; the coal capacity, 970 tons, sufficient for 6,200 miles at 10 knots.

The *Edinburgh* has a metacentric height of 9 ft.; the duration of rolling oscillations, in fighting condition, being nine seconds, the steadiness of the vessel having been very much increased by bilge keels. When the highest steam pressure was put on it reached 64¾ lbs. to the square inch. With this there was very little vibration of the ship, but a considerable wave was thrown up in front of the bows. This is, however, the case with even the very lightest of our swift unarmored cruisers when driven at full speed, and in the more recent examples a water run is constructed diagonally across the forecastle deck, to conduct the combs of the waves over the sides when they break on board. The draft from all the furnaces, being concentrated, in both of these vessels, through a single funnel, the heat generated at full speed is excessive, and it was found in the *Edinburgh* that the deck got burned in the vicinity of the funnel casing.

The armor of these vessels is disposed of as follows: Upon the sides of the citadel, which are 18 in. at the thickest part; upon the bulkheads 16 in. and 13 in.; and upon the turrets 16 in. and 14 in. There is also a teak backing from 10 in. to 22 in. The turrets are placed diagonally, so as to present, simultaneously, a broadside or an end-on fire. The upper works generally, and the upper batteries, are unprotected by armor plates. This is of course *the* serious blot in the construction of nearly all our modern battle-ships, in view of the effects of high explosives; but it will be remedied in future, as the secondary batteries are to be plated with 3-in. armor.

The armament consists of four 12-in., 47-ton breech-loading rifled steel guns; five 6-in. breech-loading steel guns, and 22 quick-firing and machine guns; also torpedo tubes. The engraving herewith gives a section of the turret and gun mountings for two of the 12-in. guns, which will penetrate 21 in. of armor plate.

The turret revolves on a roller path laid on the main or citadel deck, and its base is, in consequence, protected by the armor surrounding the citadel. It is turned by a pair of hydraulic engines placed on the deck beneath, and geared to the turret by vertical shafts and toothed wheels engaging with a rack carried near the bottom of the mounting. A special device is used to avoid any lash of the toothed wheels. These engines are controlled by a spindle passing through the axis of the piping at the center of the turret. This spindle is worked by a train of gear from either of the sighting stations; but these and other minor fittings are omitted in the engraving to avoid unduly complicating it.



The guns are loaded from the long boxes shown in the figure; and these are hinged at their rear ends to a pivot attached to the battery deck. In their normal condition they lie flush with the deck, and therefore offer no obstruction to the passage-way. They can be charged either from above or from below, as may best suit other arrangements in the ship, and, after charging, are hoisted by the hydraulic cylinder, shown under the front end, into line with the elevated guns, whenever it is desired to load them. Each box contains an hydraulic rammer, which can be used to push the charge into the gun, after it has been brought into position.

The *Edinburgh* and *Colossus* have both given great satisfaction, as good sea boats and for comfort in heavy weather. They present a steady platform for service of their guns.

THE NEW ENGLISH BATTLE-SHIPS.

THE English Admiralty purposes building eight new battle-ships of the first class, and the designs adopted for them are described in a paper recently read before the Institution of Naval Architects by Mr. W. H. White, Director of Naval Construction.

There are two designs for these ships, the Turret and the Barbette type. The following principles were laid down for the new designs:

1. That there should be four heavy guns placed in two protected stations, situated at a considerable distance apart, each pair of guns having an arc of training of about

260°, equally divided on each side of the line of keel. All four of these guns to be available on each broadside.

2. That the greater portion of the auxiliary (or secondary) armament should be placed in a long central battery, situated between the two heavy gun stations, and so disposed that there should be practically no interference with the fire of any one gun by that of any other.

3. That in view of the development of high explosives, it was desirable to secure the widest possible distribution of the guns in the auxiliary armament; and that it was preferable to mount the auxiliary armament on two decks, one of them being the spar deck, rather than to carry the guns chiefly between decks.

Each ship is to carry four 67-ton, 13½-in. guns as the principal armament, with hydraulic apparatus for training, elevating, and loading the guns. The auxiliary armament will include ten 6-in. guns, carrying 100 lbs. projectiles and a number of smaller rapid-fire guns.

The *Turret Design* is shown in outline in fig. 1. The armor protection of the hull proper includes two principal features:

1. A belt, 8½ ft. broad, extending over two-thirds the length of the vessel, and having a maximum thickness of 18-in. armor. Transverse armored bulkheads complete the belt, a 3-in. steel deck is fitted above it, and a strong protective under-water deck completes the protection before and abaft the belt.

2. The broadside above the thick belt is protected, to a height of about 9½ ft. above water over a considerable portion of the length, by 5-in. armor. Screen bulkheads, similarly armored, enclose the central battery. The protection of the heavy guns consists of 18 in. armor on the turrets, and 17-in. on the redoubts protecting the turret bases, etc.

The illustrations in fig. 1 will make this description clearer. It will be seen that each turret stands in a separate battery or redoubt, which rests upon the protective deck, and is strongly armored for the defence of the turret bases and loading apparatus. This system has been previously carried out in the *Victoria* and *Sans Pareil*, in each of which there is only one turret. The belt armor rises 3 ft. above water, and extends 5½ ft. below water. Its longitudinal extent is sufficient to insure that if the spaces before and abaft it and above the under water protective deck were flooded, very small "sinkage" and very moderate "change of trim" would ensue. The maximum thickness of the belt armor is 18 in., as against a maximum of 20 in. in the *Trafalgar;* the minimum thickness at the ends of the belt is the same as in the *Trafalgar*—14 in. The proportion of the length protected by the belt is the same in both cases. Above this thick armor belt and protective deck, the broadside is armored with 5-in. steel for a length of 145 ft., and to the height of the upper deck amidships (9½ ft. above water). Oblique armored bulkheads or screens extend across the protective deck, and meet the redoubt armor; thus completely enclosing a lightly armored citadel with its top at the level of the upper deck (9½ ft. above water), having the same extreme length as the central battery, viz., 170 ft. Within the 5-in. steel armor on the sides, coal bunkers are built, extending from the belt to the upper deck, and having an athwartship thickness of 10½ ft. When filled with coal, these bunkers would greatly reinforce the defence; when empty, the minimum defence is 5 in. of steel, which is proof against all the smaller kinds of quick-firing guns, and against many of the most destructive forms of attack from much larger guns. In the new turret ship it has been necessary to provide a long central battery (about 170 ft. in extreme length) to accommodate the more numerous and powerful guns in the auxiliary armament; and the turrets are placed about 200 ft. apart.

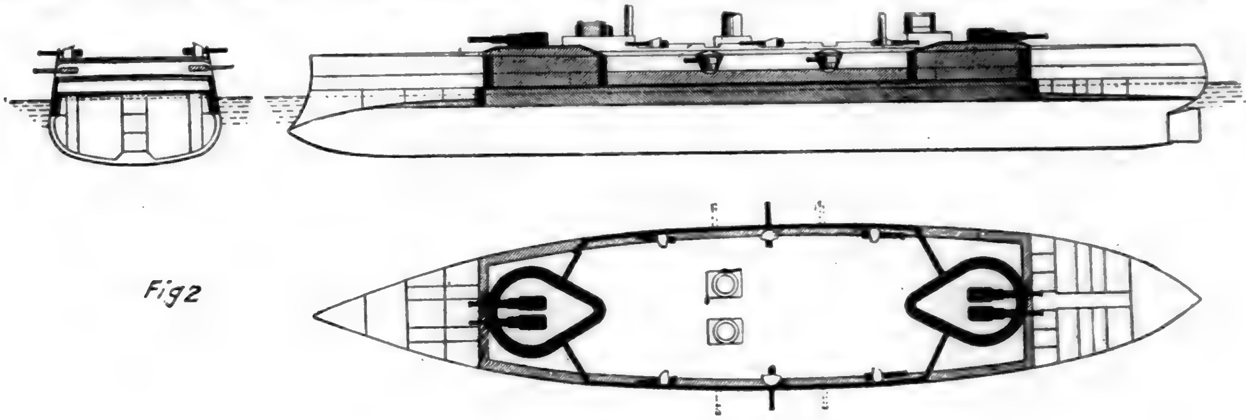


Fig2

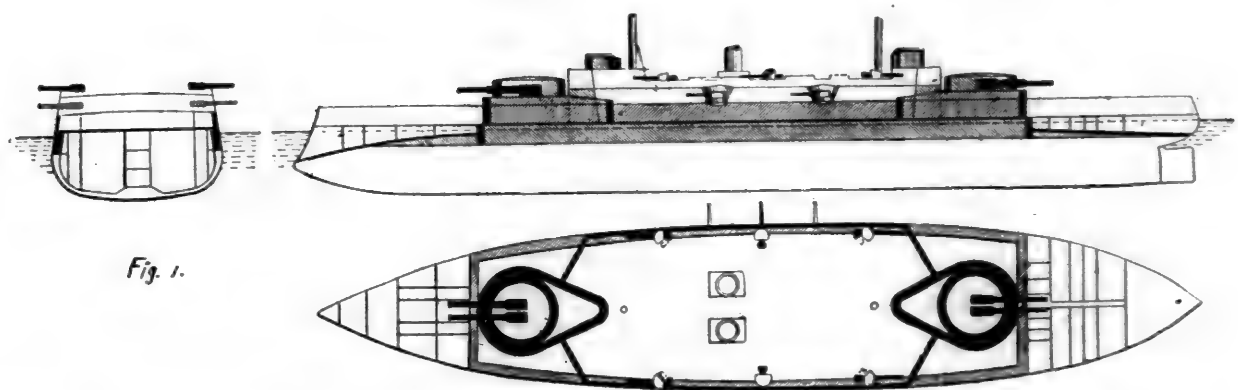


Fig. 1.

The *Barbette Type* is shown in fig. 2. In this design the freeboard at the ends is increased to 18 ft., or 6¾ ft. more than the freeboard in the turret ship, and about 7 ft. 4 in. more than in the *Trafalgar* as completed. The heavy guns are carried 23 ft. above water, as against 17 ft. in the new turret ship, and about 15 ft. as designed, or 14 ft. as completed, in the *Trafalgar*. In the English Navy a very large proportion of most recent and powerful ships are of moderate freeboard, carrying their guns only 12 ft. to 14 ft. above water; whereas in foreign navies, in recent years, the heavy guns are chiefly carried from 22 ft. to 28 ft. above water, and the freeboard is high. The decision of the Admiralty to largely adopt the barbette design is avowedly based on these facts, and arrived at with a full knowledge of the relative advantages and disadvantages of the turret and barbette systems, after considering designs for turret ships with guns placed at equal height

above water, and with the same freeboard as the barbette ship. It will be obvious that the increase in height of freeboard and of guns above water can only be secured by means of additional hull weights, and rearrangements of the armor. What has been done is this: The turrets have been abolished, and the weight of armor, etc., is utilized in adding to the height of the redoubts in which the turret bases stand. The barbettes thus formed are strongly armored from the 3-in. protective deck above the belt upward, and are divided into two stories. In the upper story stand the turn-tables carrying the heavy guns, in the lower story will be placed the turning engines and other important portions of the equipment. In most barbette ships hitherto built, whether English or foreign, the barbettes have been shallow armored cylinders, with plated bottoms, standing on light steel structures at a considerable height above the belt deck. Armored tubes have been fitted to protect the ammunition when it is passed up from the magazines into the barbettes. This system greatly economizes weight of armor, but the development of high explosives makes it possible that shells containing bursting charges of great energy might be exploded immediately under the floors of the barbettes. Consequently, it has been decided in the new ships to adopt the alternative system above described, although it involves a very large expenditure of weight and cost on armor. The hydraulic system of mounting, working, and loading the 67-ton barbette guns, to be carried out in the new ships, will resemble closely that already successfully adopted in the *Admiral* class. As regards the disposition of the belt armor, protective deck, and 5-in. armor, as well as the protection of the auxiliary armaments, the barbette ships are identical with the turret design already described.

It was originally contemplated to adhere in the new designs to the speed that had been first accepted for the *Trafalgar*, viz., 15 knots on the measured mile with natural draft, and 16½ knots with forced draft. In working out the designs, it has been found possible to increase these speeds to about 16 knots natural draft, and 17½ knots with forced draft. These estimates of speed are based upon model experiments made in the Admiralty establishment at Haslar, by Mr. R. E. Froude, and upon an analysis of the results of speed trials of recent ships.

As to coal supply, it was decided, after full consideration, that the new ships should ordinarily carry 900 tons of coal, and be capable of covering about 5,000 knots at 10 knots. The new ships will have a bunker capacity sufficient to carry a much larger quantity of coal if desired, and in these designs provision is made (in the form of the so-called "board margin") for an unappropriated weight exceeding 500 tons to be carried at the designed load draft and at the full speed. If the unappropriated weight should be assigned to coal, it would give the new designs a coal endurance of nearly 8,000 knots at 10 knots. Apart from any such increase in coal, however, the 900 tons proposed is a very large supply in relation to expenditure; larger, in fact, than that of nearly all first class battle-ships. At the highest speed contemplated for smooth water, continuous steaming—about 16 knots—the new ships could cover about 1,900 knots.

These new ships will be of about 14,000 tons displacement, and will be among the heaviest fighting ships afloat. Their designs have called out severe criticism, especially from those who do not believe in the usefulness of such very large, unwieldy, and costly vessels.

TRANSITION CURVES.

BY CHARLES DAVIS JAMESON, C.E.

(*Continued from page* 228.)

WE will now pass to the development of a Transition Curve that shall comply with all the requirements, both theoretical and practical.

1. It commences with a radius of infinity. The radius decreases until it becomes equal to the radius of the circular curve, at which point it is tangent to the circular curve.

2. The length of the radius at any point is inversely proportional to the distance of the point from the starting-point. (This is only true within narrow limits with the following transition curve. The advantages of a departure from this rule will be explained):

3. The length of offset between the original tangent and the main circular curve can be varied at will within certain limits, thus rendering the line flexible and elastic.

4. The work required in the field in running in these transition curves is no more than that required on the ordinary circular curve, and this, taken in connection with the acquired flexibility of the line, reduces amazingly the total amount of field work necessary to fit the line to the configuration of the ground.

In order to vary the lengths of the offset, the only change necessary is in the length and rate of change of direction in the transition curve; that is, for every change in the length of offset there must be used a different transition curve. This has led to the calculating or tabulating of 12 different curves for each degree and half-degree of change in the radius of the main circular curve. These tables will be given hereafter.

Within these limits are included all probable changes that will be required in actual work.

One of the most successful attempts to reduce the theory of the transition curve to practice is "The Railroad Spiral," by William H. Searles. This curve is composed of a succession of circular arcs of constantly decreasing radius, the radius of the one joining the tangent being so long that there is practically no shock felt upon entering it. The curve is located by deflection angles, the chord used not being 50 ft. or 100 ft. long, but of a length varying according to the length of the transition curve. This chord-length varies from 10 ft. to 50 ft.

The drawback to the general adoption of this so-called "Railroad Spiral" is that it lacks entirely the feature of flexibility, and when used leaves the line as rigid as ever. It also lacks to some extent ease and facility for use in the field, owing to the number and extent of the tables necessary.

The curve known as the cubic parabola approaches more nearly to the theoretical transition curve than any other. The various advantages possessed by this will be taken up later.

The few attempts that have been made to reduce this curve to a practical transition curve do not fulfil all the required conditions; either a single parabola has been calculated and made to answer the conditions of all the transition curves, or the curves selected are so limited in length and in the amount of offset which they give between the tangent and the main circular curve, that they practically fix the position of both tangent and curve, and thus do away with any flexibility of the line.

In the development of the following formulas and the calculation of the tables necessary to make practicable the use of the cubic parabola as a transition curve, the Author takes pleasure in acknowledging his indebtedness to Mr. E. W. Crellin, of the Junior Class, Engineering Department, State University of Iowa.

The equation of the cubic parabola referred to rectangular axis may be written:

$$x^3 = c\,y. \qquad (4)$$

In this c is a constant for any given parabola. Differentiating this equation, we obtain:

$$\frac{d\,y}{d\,x} = \frac{3\,x^2}{c}, \qquad (5)$$

which gives the tangent of the angle which the curve at any point makes with the axis x. In the above equation, let $x = 0$, and we have

$$\frac{d\,y}{d\,x} = 0.$$

That is, the tangent of the angle which the curve at the origin of the axis makes with the axis x is equal to 0. Consequently, the angle is equal to 0, and the curve at that point is tangent to the axis of x.

We now derive the formula giving the radius of curvature at any point of the cubic parabola. The following is the general formula for the radius of curvature of any curve:

$$R = \frac{\left(1 + \frac{d y^2}{d x^2}\right)^{\frac{3}{2}}}{\frac{d^2 y}{d x^2}} \qquad (6)$$

R is the length of the radius at any point. Taking the first and second differential coefficients of the equation $x^3 = c\,y$, and substituting in this formula, we obtain :

$$R = \frac{(c^2 + 9\,x^4)^{\frac{3}{2}}}{6\,c^2\,x}. \qquad (7)$$

By assuming values for c and then substituting various values for x, the corresponding radii of curvature are obtained. If we make x equal o, R becomes ∞, showing that the curve is tangent to the axis of x, with a radius of infinity. If we neglect the term of the numerator containing x (since it will always be small in comparison with c), we have :

$$R = \frac{c}{6\,x}, \qquad (8)$$

which shows that the radius of curvature is *nearly* inversely as the length of the curve from starting-point, measured along the axis.

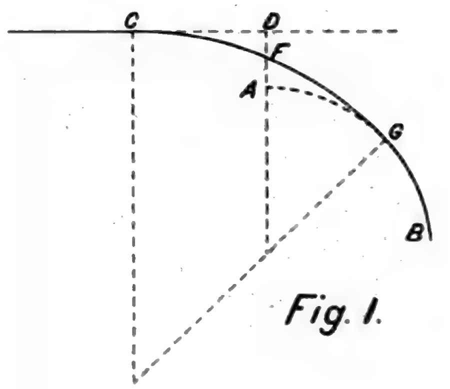


Fig. 1.

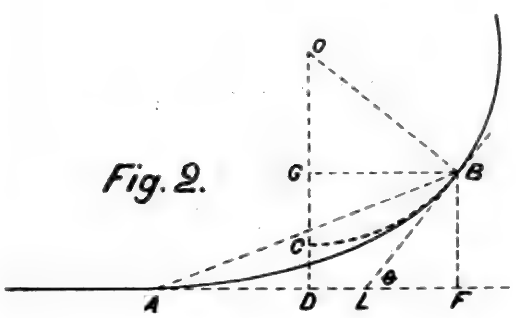


Fig. 2.

We thus have two of the properties of the perfect transition curve.

1. The radius at starting from the tangent is infinity.
2. The radius gradually decreases, varying nearly inversely as the distance from the origin. The fact that in the above demonstration we have assumed that the length of the curve is equal to the abscissa will make no material difference in the equation.

To be more exact, the *rate of change* becomes a little less the farther it recedes from the origin. This slight variation of the cubic parabola from the rule that the radius of curvature should vary inversely as the length is rather an advantage, for the reason that, as the curve approaches this point of contact with the circular curve, the curvature is becoming sharper and a slight decrease in the rate of change is advisable. Thus, if a curve were changing at the rate of one degree of curvature per station near the tangent, it would change at the rate of 50 minutes per station near its union with the circular arc. This is one of the advantages of the cubic parabola, the merits of which are taken up later in regard to the superelevation of the outside rail. It does not become apparent unless a considerable portion of the curve is considered. None of the spirals that have been employed for transition curves have such a property. The rate of their change is a constant from the point of tangent to the point of curve.

Obtaining the differential coefficient of the equation :

$$R = \frac{(c^2 + 9\,x^4)^{\frac{3}{2}}}{6\,c^2\,x}, \qquad (9)$$

we have :

$$\frac{d\,R}{d\,x} = \frac{324\,c^2\,x^4\,(c^2 + 9\,x^4)^{\frac{1}{2}}}{36\,c^4\,x^2} - 6\,c^2\,(c^2 + 9\,x^4)^{\frac{3}{2}}. \qquad (10)$$

Equating to o, and solving for x, we have :

$$x = \frac{\sqrt{c}}{2.59+}, \qquad (11)$$

which means that when $x = \frac{\sqrt{c}}{2.59}$, R is a minimum. At this point the radius of curvature ceases to diminish and begins to increase again after passing it. It is evident that this point of minimum radius fixes the limit of the transition curve. Substituting this value (10) in the equation for the radius of curvature, we get after reduction :

$$R = \frac{(\frac{6}{5})^{\frac{3}{4}}\,(45)^{\frac{1}{4}}\,c^{\frac{1}{2}}}{6} = 0.5674\,\sqrt{c}. \qquad (12)$$

This gives a minimum radius of curvature in terms of the constant c. In the same manner, by eliminating c instead of x we obtain a minimum radius in terms of the length of the curve :

$$R = 1.469\,x, \qquad (13)$$

That is, the least radius of curvature which can be obtained by the given parabola is not quite $1\frac{1}{2}$ times the length of the curve to the point of minimum radius.

Applying the general formula for the co-ordinates of the center of curvature :

$$m = x - \frac{\left(1 + \frac{d y^2}{d x^2}\right)\frac{d y}{d x}}{\frac{d^2 y}{d x^2}}, \qquad (14)$$

$$n = y + \frac{1 + \frac{d v^2}{d x^2}}{\frac{d y^2}{d x^2}}, \qquad (15)$$

we obtain the position of the center of curvature.

In fig. 2 let o be the center of curvature. Then $n = O\,D$ and $m = A\,D$. Making the necessary substitutions in the above formula, we find :

$$m = \frac{x}{2} - \frac{9\,x^5}{2\,c^2}, \qquad (16)$$

$$n = \frac{c^2 + 15\,x^4}{6\,c\,x}. \qquad (17)$$

The second member of (16) is composed of two terms, the first being one-half the whole length of the line $A\,F$; the second term will always be very small, since x is small in comparison with c. The distance $A\,D$, then, will be always a little less than one-half of $A\,F$. The offset $C\,D = O\,D - O\,C$. $O\,D = n$, we have from (17), while $O\,C = O\,B$ is the radius of curvature at the termination of the transition curve. Therefore, we have :

$$d = O\,D - O\,C = n - R = \frac{c^2 + 15\,x^4}{6\,c\,x} - R, \qquad (18)$$

where d is the length of the offset $C\,D$. Making the necessary substitutions to find the value of d when R is minimum, we find :

$$d = (45)^{\frac{1}{4}}\left(\frac{2}{9} - \frac{1}{6}\left(\frac{6}{5}\right)^{\frac{3}{2}}\right)\sqrt{c}, \qquad (19)$$

$$d = 0.00812\,\sqrt{c}, \qquad (20)$$

The results are expressed in the following table:

c.	Radius.	Length.	d = Offset.
10	179	122	2.6
25	284	193	4.0
50	397	273	5.7
100	567	386	8.1
200	802	546	11.5
500	1268	863	18.1
1000	1792	1220	25.6

From this table it may be seen that for a 7-degree curve, for instance, radius 819 ft., the longest transition curve that can be obtained will be about 550 ft., and the greatest offset about 12 ft.

From the above properties of the cubic parabola it is evident that a single cubic parabola would furnish transition curves for all circular arcs of a greater radius than its minimum radius of curvature. It is necessary, then, to calculate as many parabolas as it is desired to have curves for each arc, and in the following tables* we have selected 12 different parabolas, giving as many different lengths of transition curves and offsets, $C\,D$, for each degree of circular curve named. By assuming various values for the constant c, and computing the distances $A\,F$, $A\,B$, $A\,D$, $B\,F$, $C\,D$, and the angles $B\,A\,F$ and $B\,L\,F$ corresponding to the various lengths of radius, $O\,B$, the tables have been constructed. The angle $B\,L\,F$, as will be noted, is the angle between the original tangent and the angle between the parabola and circular arc at the point where they unite. From (7) (the radius of curvature of the cubic parabola), if there are given the values of c and R the value of x cannot be taken directly, this being an equation of the 12th degree, for which there is no general method of solution. The usual methods of approximation are unsatisfactory on account of their great length, and the following method has been used, which gives results of much greater accuracy than is necessary for the purposes of the transition curve.

Writing (7) in the form of:

$$x = \frac{(c^2 + 9x^4)^{\frac{3}{2}}}{6\,c^2\,R}, \qquad (22)$$

x will always be quite small in comparison with c, and an approximate value of x substituted in the second member of the above equation will give a very accurate value for the same quantity. Take equation (7), give c a constant value, and substitute various values for x. With these values of x and the corresponding values of R so obtained, construct the curve shown in fig. 3, in which the values of R are abscissas and those of x ordinates. By simply laying off on the line $A\,B$ distances corresponding to the radii of the circular curves of different degrees, and measuring the ordinates, the values of x will be obtained with more or less exactitude, depending upon the care with which the curve has been constructed. By substituting the values of x thus obtained, in the second member of (22), the values of x given in the tables are obtained. These will be found in the column marked "Length along Tangent." The corresponding distances are measured along the curve in chords of 50 ft. The distance $A\,D$ was obtained from the equation previously given (16). These are the numbers in the column headed "M."

The ordinates $B\,F$ at the end of the transition curve can be found directly from the equation of the curve (4), y being the required ordinate. The total deflection angle, $B\,A\,F$, is the angle whose tangent is:

$$\frac{y}{x} = \frac{x^2}{c}, \qquad (23)$$

this last result being obtained from the equation of the parabola.

These angles obtained from a table of tangents are placed in the column headed "Total Deflection." The tangent of the angle which a tangent to a curve at any point makes with the axis of x is equal to the value of the differential coefficient of the equation of the curve with reference to x, with the co-ordinates of the given point substituted.

In the case of the cubic parabola:

$$\frac{d\,y}{d\,x} = \frac{3\,x^2}{c}, \qquad (5)$$

which gives the tangent of the angle $B\,L\,F$.

These angles are placed in the column headed "Deflection for Tangent."

The numbers in the column headed "Offset = d" are the distances $C\,D$.

From fig. 1.

$$C\,D = B\,F - C\,G = \frac{x^3}{c} - O\,B\,vers.\,B\,O\,G = \frac{x^3}{c} - R\,vers.\,\theta, \qquad (24)$$

θ = the angle $B\,L\,F$ already obtained. From the above equation the values of d have been obtained. In the "Deflection and Offset Table" is given the necessary data for locating intermediate points. The deflection angles are given for the termination of every 50-ft. chord. Offsets from the tangent are also given every 50 ft., measured along the tangent.

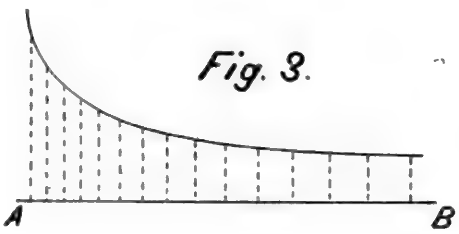


Fig. 3.

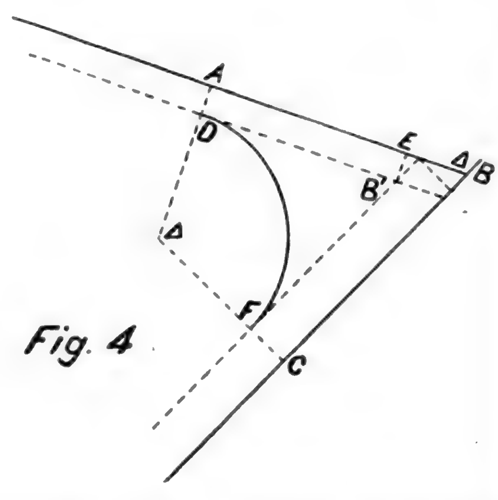


Fig. 4

(TO BE CONTINUED.)

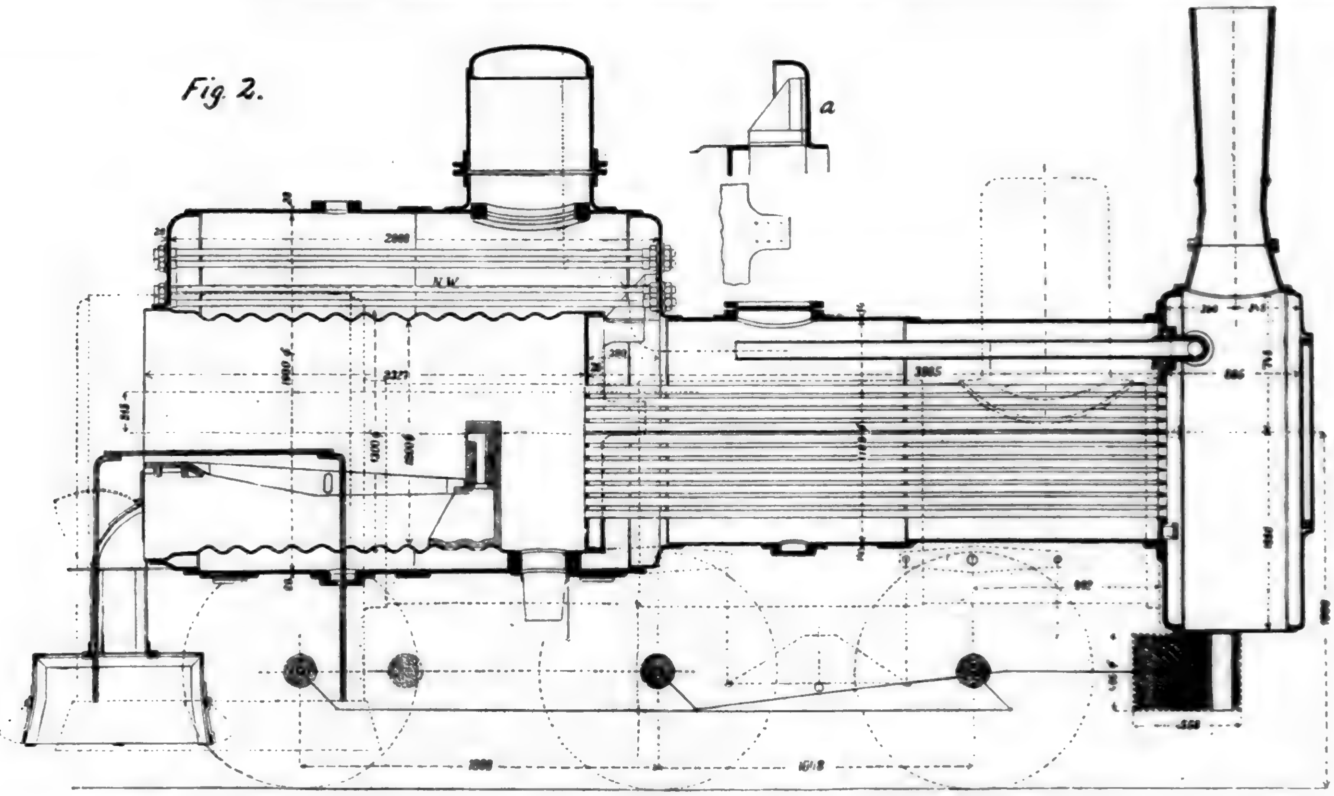
CORRUGATED TUBULAR FIRE-BOXES FOR LOCOMOTIVES.

(Condensed from paper read by Herr Otto Knaudt before the German Mechanical Engineers' Union.)

SINCE the first establishment of railroads there has been a constant increase in the size and weight of the motive power. We have already cylinders as large as 24 and even 26 in. in diameter, while the pressure of steam has also been constantly increased until now working pressures of 150 and 180 lbs. are used, and for the better utilization of this high pressure the compound system is on trial. In order to meet these demands boiler-makers have been continually improving their work, but while the size and weight of boilers have been increased, there has been

* The tables here referred to will be given hereafter.

Fig. 2.



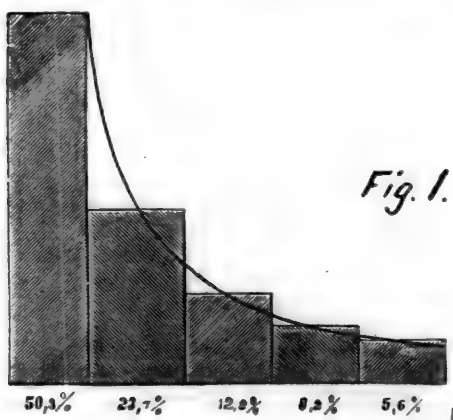


Fig. 1.

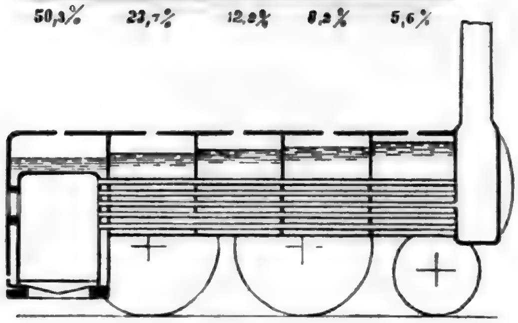


Fig. 3.

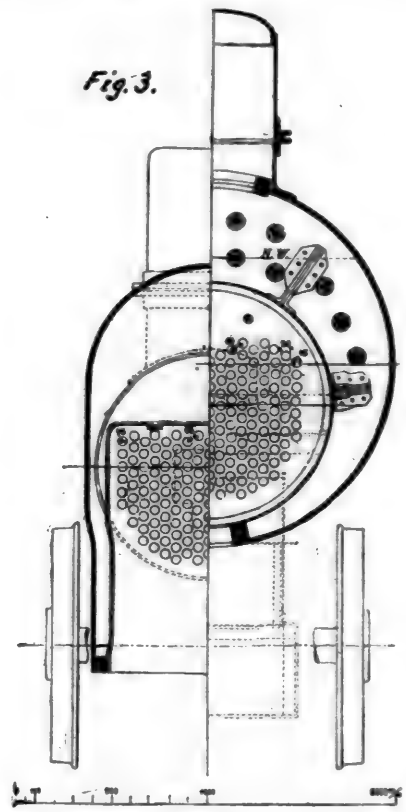


Fig. 4.

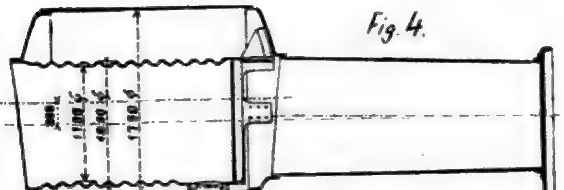
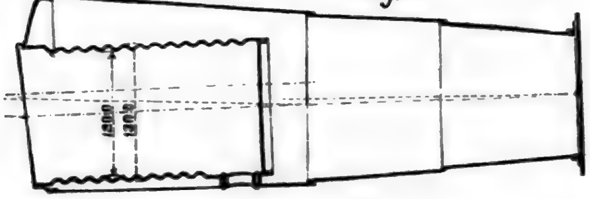


Fig. 5.



very little change in the general form and arrangement of those used for locomotives.

Careful investigations have, however, been made of the relative value of the heating surface of different parts of the boiler; the accompanying diagram, fig. 1, which was prepared by M. Lencauchez, shows in graphic form the relative value of the heating surface of the fire-box and of different portions of the tubes; the latter are, in the diagram, divided into sections and the relative value of the different sections is expressed by the shaded rectangles. From this diagram the value of an increase of fire-box surface can be readily seen.

As the size of locomotive boilers increased, the cylindrical forms which were at first used were generally aban-

doned, and the square or rectangular fire-box was adopted necessarily, because the width of this part of the boiler was limited by the distance between the wheels of the engine. This form requires an extensive system of stays and stay-bolts in order to give its flat surfaces the proper strength. As the size of stationary and marine boilers increased the circular fire-box was also generally abandoned on account of the difficulty of securing sufficient strength, until the adoption of the corrugated tubes, which are made in England by Samson Fox at the Leeds Forge; in Germany by the Schultz-Knaudt Works in Essen, and in America by the Continental Iron Works in Brooklyn. The demand for these tubes has increased so that in England over 3,000 tons a year are turned out, and

The new boiler had the same diameter of barrel as the old one at the forward end, and at the back end this was increased to 1.900 meters (6 ft. 3 in.), as shown in fig. 2, and a corrugated tube 1.200 meters inside and 1.300 outside diameter was introduced. The number of tubes was increased from 160 to 187, but the tubes are shorter than in the old boiler, being 3 meters (9 ft. 7½ in.) in length. The total heating surface is 98.2 sq. m. (1,057 sq. ft.), of which 10.1 sq. m. (10.3 per cent.) are in the fire-box.

The tubular fire-box is so set that the riveting is below the water level, and the seams can all be calked from the inside. The method of staying the fire-box to the outside shell by the use of gusset-stays and anchors is shown in

Fig. 1.

M. N. FORNEY'S IMPROVED CAR SEAT.

it is to be noted that the greater part of these are required to stand the pressure of not less than 150 lbs. in practice.

The Schultz-Knaudt firm, being naturally anxious to extend the use of these tubes, sought to make arrangements with different locomotive builders to introduce them, and finally agreed with Herr Pohlmeyer, the Director of the State Railroad Shops at Dortmund, Westphalia, to make the experiment. A boiler fitted with the cylindrical fire-box was applied on a freight engine having six coupled drivers, with cylinders 16 in. in diameter and 22 in. stroke. The engine was at the time in the shops for rebuilding, and the old cylinders, frames, and wheels were used, only the boiler being changed. Fig. 2 shows a longitudinal section of the boiler as constructed, the light dotted lines showing the outline of the old boiler and fire-box. Fig. 3 shows on one side a half-section of the new boiler with corrugated fire-box and on the other a half-section of the old boiler.

The old boiler had 160 tubes 4.27 meters (14 ft.) in length and the total heating surface was 95.7 sq. m. (1,030 sq. ft.), of which 6.1 sq. m. (6.4 per cent.) were in the fire-box and the remainder in the tubes.

detail at *a*, fig. 2, and in fig. 2 also can be seen the method of staying the flat surfaces of the rear end of the boiler. The arrangement for carrying the grate-bars and the fire-brick bridge forming a combustion chamber is also shown in fig. 2, as well as the manhole provided for removing the ashes which may collect in front of the brick arch at the bottom of the combustion chamber.

This form of boiler was adopted in this case because it was substituted for an old boiler, and it was desirable not to make other changes in the engine. A much better form of boiler, in the opinion of Herr Knaudt, stronger and more easily braced, would be a circular or conical one, as shown in fig. 5, where it is contrasted with the form actually adopted, shown on the same scale and in outline in fig. 4.

This boiler with the tubular fire-box has been in use since June, 1888, and has given entire satisfaction in every respect. The boiler steams well in practice, has abundant water-room, and the locomotive is relied upon to do somewhat more work than others of the same class. The only objection that could be raised against it is that the large diameter required for the back end would make it neces-

sary to raise the center very high in an engine with large drivers.

Herr Knaudt notes the adoption of these fire-boxes on the Strong locomotive in the United States as a favorable sign. He claims that the plain boiler with the corrugated fire-box can be more cheaply built than the ordinary locomotive boiler, and that it will cost less for repairs, while it will stand a higher pressure. As to the strength of the corrugated tubes they are now in use at working pressures as high as 200 lbs., while tubes of 4 meters (13⅛ ft.) in diameter with pressures of 150 lbs. are constantly employed, and there is no difficulty in making tubes 2 meters in diameter for the highest pressures yet used.

Fig. 2.

M. N. FORNEY'S IMPROVED CAR SEAT.

FORNEY'S IMPROVED CAR SEAT, WITH ADJUSTABLE FOOT-REST.

With all car seats as now made there is more or less difficulty in sweeping and cleaning below the seats. The seat itself and the frame which connects the stand next to the aisle of the car, with its side and the foot-rests, are all in the way, and prevent free access to the floor below the seats, and the consequence is that it is always difficult to scrub or sweep the floors thoroughly, and, as a consequence, cars are nearly always imperfectly cleaned. Figs. 1, 2, 3, 4 and 5 represent an improvement in the seats, which are now known by the name of the inventor, the aim of which is to provide a foot-rest whose height can be adjusted, and which, with the seat, can be raised up so as to leave a clear space below for cleaning the floor.

In order to make its construction quite clear to those who are not acquainted with the mechanism of what is known as the Forney seat, a little preliminary explanation of its peculiarities may be needed. Fig. 1 is a perspective view of the seat complete; fig. 2 is a perspective view, with the seat-cushion removed, so as to show the construction more clearly; fig. 4 shows the seat and foot-rest raised up, and the back turned half way over for cleaning the car. Fig. 4 shows an end elevation, with the arm omitted; fig. 5 is a similar elevation, with the seat and foot-rest tipped up and the back turned half way over, and fig. 6 is a front view of the old style of seat. The seat-back is reversed from the one position to the other by means of two pairs of crossed links, or arms, *L L'*, fig. 4, one pair at each end of the seat. These are connected to the seat-end and side of car by fixed pivots *P P'*, and to the seat-back by other pivots, *p p'*. The arms project below the fixed pivots *P P'*, and each of them has a projecting pin or stud *s s'*, which support the seat. The seat or cushion-frame has slots *n n'* in each end which receive the pins *s s'*. These slots allow for the variation in the distance apart of the pins which occurs when the back is reversed. By reversing the back, the seat is moved horizontally; and its inclination is also reversed, so that in both positions of the back it inclines backward, which adds materially to its comfort.

With this mechanism for reversing the backs they can be made of any required height, and, as appears from the illustrations, their lower edges come above the tops of the seats. This leaves the space behind the seat entirely clear, so that with seats of this kind there is more room than with those ordinarily used.

It will also be seen that the fixed pivots *P* and *P'* are

located on a line with the top of the seat. With the ordinary method of reversing backs, the seat-arm pivots about which the backs turn must be placed so far above the seats that the arm-rests are elevated at an uncomfortable height, so that the shoulders of passengers are raised up into an uneasy position. The location of the pivots *P P'*, shown in the engravings, permits the arm-rests and window-sills to be lowered to any position that will be most conducive to comfort. The fact that the arms of drawing-room car chairs are always made much lower than those of ordinary car-seats is evidence that the latter are too high. But if the window-sills are lowered so as to be of the most comfortable height for arm-rests, there is danger when they are open that persons will put their arms or feet outside and be hurt, and children standing up on the seats may fall out. For these and other reasons, the method of construction shown in figs. 1, 2 and 3 has been devised. The connects the stand with the side of the car, may be entirely omitted. The foot-rests *C*, as shown in fig. 6, have usually been made stationary, and cannot be adjusted to varying heights, and are in the way when the car is cleaned.

In the seat illustrated by the engravings the foot-rests *C C*, fig. 2, are attached to arms *D D*, which are attached to fixed pivots, *A*, at each end of the seat. The foot-rests can thus turn about those pivots as centers, and will describe the arcs *a b c*, as shown in fig. 5. Pawls *E E*, fig. 2, are attached to the under side of the foot-rest *C*. These pawls engage in ratchets *G G* fastened to the floor, and thus hold the foot-rest in any desired position. To raise the foot-rest, all that is needed is to put the foot under it, and as it is raised up the ratchet moves from one notch to another, and will hold up the foot-rest in any position in which it is placed. The foot-rest can be lowered by raising the ratchet out of the notch it is in and adjusting it in any one that is desired. The

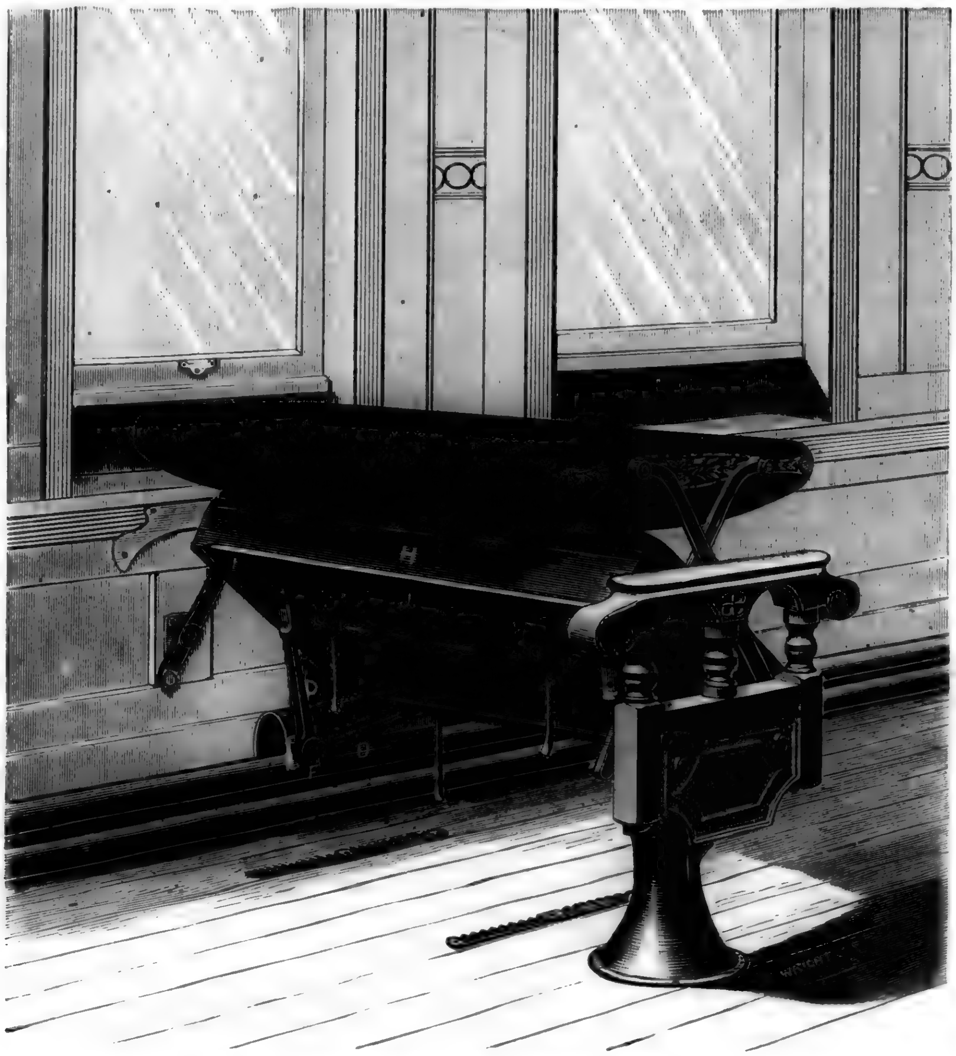


Fig. 3.

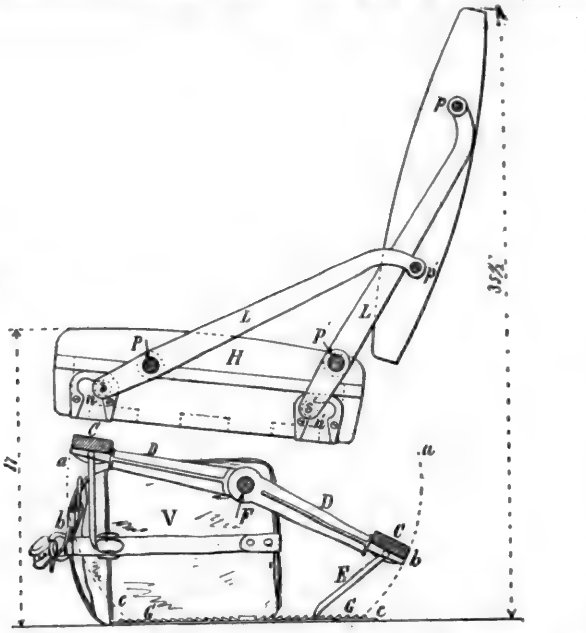
M. N. FORNEY'S IMPROVED CAR SEAT.

window-ledge has been placed 24 in. above the top of the floor. This is just about the height of a drawing-room car chair-arm. Under the window *W*, a recess or pocket *R* is constructed, which is flush with the outside of the car. This makes the ledge wide enough for a comfortable arm-rest, or it can be used as a shelf to hold books or packages.

The special improvement to which attention is called in this article is the construction of the foot-rest and the seat-stand, and the advantages resulting therefrom. Car seats as heretofore made have stands, *S*, fig. 6, next to the aisle, which are connected to the side of the car by a frame, *A*, on which the seat usually rests. The only function performed by this frame in the Forney seat has been to give lateral support to the stand. It is obvious that by making the stand, *S*, fig. 2, of a bell-shape and fastening it securely to the floor that no lateral support would be needed; and as the seat-cushion is supported by the pivots *S S* on the ends of the arms *L L'*, that the frame *A*, of fig. 6, which two pawls *E E* on each foot-rest are connected together, so that when one is raised or lowered the other moves with it. As the seat, *H*, rests on the pivots *SS'*, it can be turned or tipped up on either pair of them, as shown in figs. 3 and 5. One of the foot-rests can then be turned up into the position shown in the same figures, and it can engage with one of the slats, *J*, in the under side of the seat, and in this way the foot-rest holds up the seat and the seat holds up the foot-rest; and owing to the absence of a cross-frame under the seat, leaves a clear space for cleaning, as shown in fig. 3. The absence of any cross-frame to the seat also leaves clear space enough below it to receive a valise, as shown in figs. 1 and 4, or other piece of baggage, or package not too large to go below the seat. The foot-rest being movable, permits of its being raised up to put a package below the seat. A receptacle for hats, coats, or other objects could also be attached to the under side of the seat, as is now done in theaters and other public places.

The back of the seat shown in the engravings is 35½ in. high from the top of the floor. The plan of construction

Fig. 4.



illustrated permits of the backs being made of any required height. Each foot-rest can also be made in two parts, so that each occupant of a seat can adjust his or her foot-rest to suit themselves.

Further information about these seats, prices, etc., may be obtained from the Scarritt Furniture Company of St. Louis, Mo., which is mantacturing them, or of M. N. Forney, 145 Broadway, New York.

ENGINEERING UNDER THE EQUATOR.

A CORRESPONDENT, who is at present engaged in making surveys in Siam, writes as follows of the experiences and trials of an engineer in that distant country.

Siam has not got any white elephants, unless the term be employed figuratively, but to one unaccustomed to Asiatic life there is much that is interesting even without them. The people are a pretty poor lot, and business is principally in the hands of the industrious Chinaman. Outside of Bankok, of which I have seen little, there are no roads, only villainously bad pack-trails; the rivers are

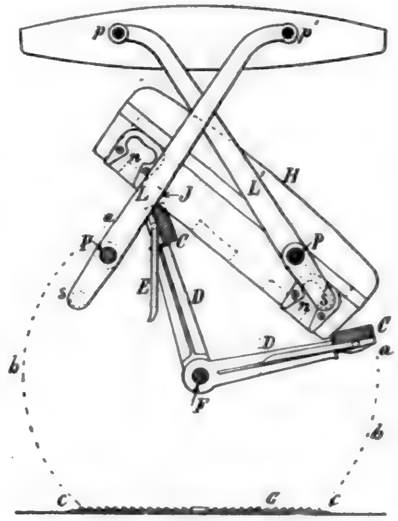


Fig. 5.

the highways of commerce. The country towns are partly afloat on bamboo rafts, and such houses as occupy the land are raised on posts and built haphazard fashion in the timber fringing the stream.

Flat—almost dead-level—valleys, divided by low dikes into little paddy (rice) fields, with bunches of standing timber and countless ant-hills, constitute the most populous district. There is gold—more or less—in the streams, and copper in some of the ranges. The hills are jungle-clad, and my ink is not black enough to paint the character of the jungle. Creepers and thorns make exploring and swearing inseparable. The natives are very ignorant and cowardly; as an instance, the *ghosts* put a stop to my operations until I got from Bankok a crew of Burmese men, fine fellows, and beautifully tattooed. We speak five languages—one in two distinct dialects—in this camp now, and the only white assistant I have knows none of them but his own. I have picked up Malay myself, which is the common language throughout the Peninsula and Archipelago, but Siamese, being a tonal language like Chinese, comes slowly.

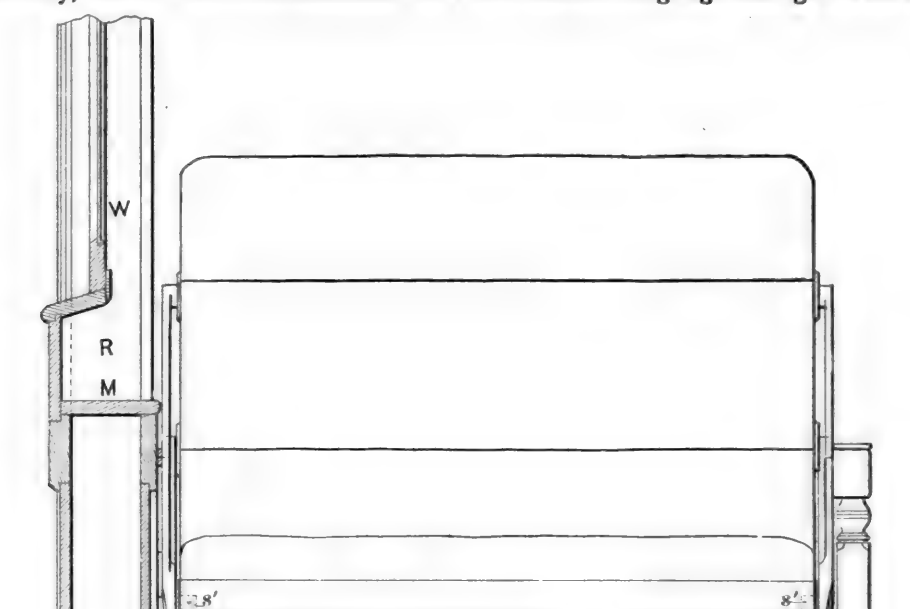


Fig. 6.

If any one wants to be convinced as to the relative benefits resulting from Christianity and heathenism, let him come to Siam, where Buddhism is in full possession. He may also conclude that if British domination be not desirable, at least a few sanitary engineers from Britain, or any other country where the profession flourishes, would be an acquisition to Bankok.

As usual, the terrors of the climate fade somewhat on close investigation. Sunstroke results principally from brandy and high-art cooking, and although I am in the heart of the fever country there seems not the slightest danger during this, the dry season, if one drinks water only after it has been boiled. I expect to be detained here till the rains have well begun, and will then use a little quinine daily. I shall see a tiger when I go back to Bankok, if Charini's circus be there.

Land transport is by paddy-carts and pack-bullocks; the former are drawn by two buffaloes, have a pair of enormous wheels, with double bearings—like a great Western express engine—and a high and very narrow body. The pack animals carry baskets ingeniously pierced by a pole crossing the animal's back, so that the basket mouth is effectually closed to anything much larger than a handkerchief. The coolies carry next to nothing, and on the whole transport is about as hard as on the Canadian Pacific surveys fifteen years ago.

Speaking of the Canadian Pacific, there could hardly be a greater contrast than between the solemn, silent Northern pine forests and this jungle, full of sound from enormous crickets and wailing monkeys; the noise the former make is astonishing. There are plenty of birds, too, but few melodious ones. The crying monkey—if he is a monkey—I have never seen, though we hear them almost daily; but the common fellow, with his long tail and his noisy chatter, frequently appears in the branches overhead, and in a violent passion.

The best man I have is a little Malay-speaking Chinaman, whom I took in Singapore from between the shafts of a rickshaw—a miniature hansom cab, with a man instead of a horse. The Chinaman has one fine quality which raises him away above other Asiatics—he is industrious; and when you get one who adds to that truthfulness and intelligence you are very lucky indeed—in Siam.

Now I must close; I suppose that, in spite of your mild weather up to January, the snow gangs are busy enough at this date—March—and the rotary plow has been winning new honors. I wish some enterprising gentleman would get up a rapid-jungle clearer and test it ahead of me. I have 60 miles to run yet, and rain promised in two months. Don't be persuaded that engineering in Asia is always a picnic.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page* 216.)

CHAPTER IX.

SECTION-HOUSES CONTINUED.

PLATES Nos. 19, 20, 21 and 22, together with the following bills of material, complete the series of plans of section-houses. The standard plans used upon the Atchison, Topeka & Santa Fé Railroad have been selected for this series, from the fact that they are more complete than any other that could be obtained by the Author, and also from the fact that they seemed in every case to better fulfill the requirements of the occasion.

It must be understood that the Author, in presenting these plans to the engineering profession, does not present them as a set of plans that should be followed exactly in every case, but more as a set of plans, together with the bills of material, that shall be suggestions from which engineers can form plans and ideas that shall suit exactly the required conditions in any particular location.

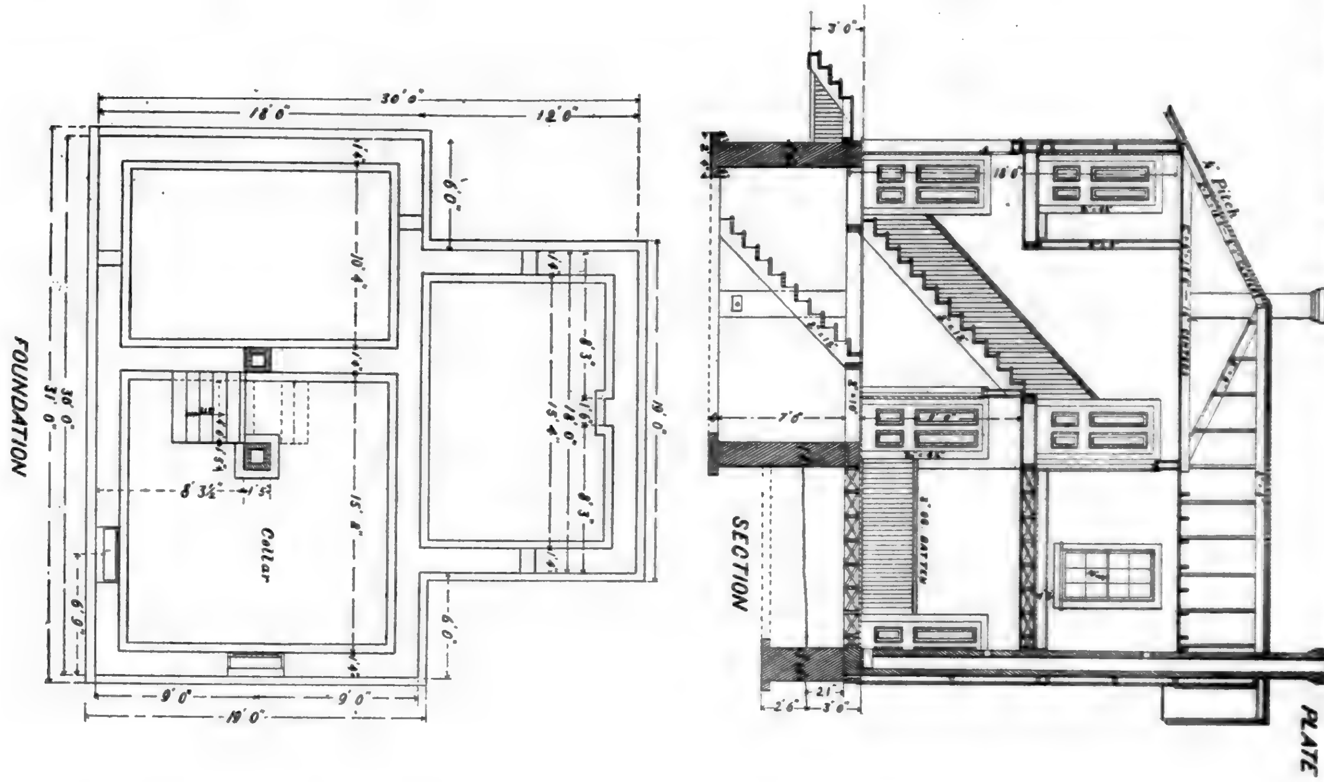
No. 30. Bill of Material for Section-House. No. 2, Atchison, Topeka & Santa Fé Railroad.

Finished Lumber.

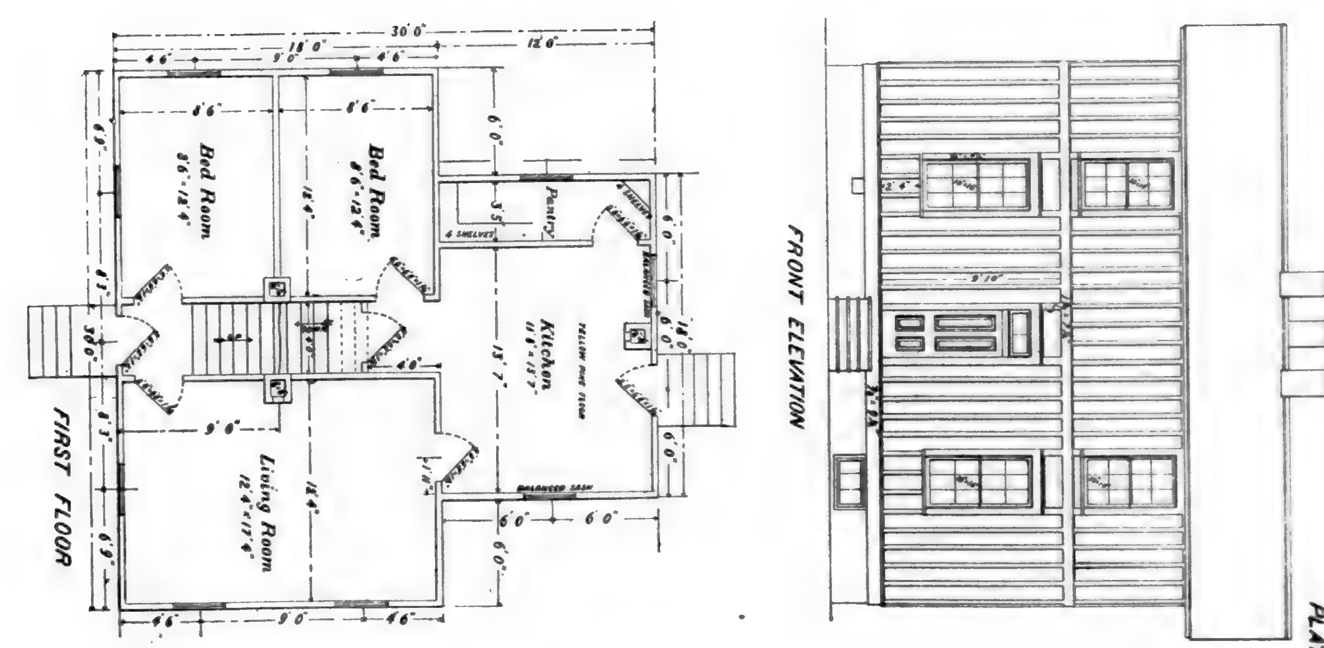
2 outside door frames with transoms.
4 pieces 1¾ in. × 7½ in. × 9 ft. clear W. P. jambs.
1 piece 1¾ in. × 7½ in. × 7 ft. clear W. P. heads.
1 piece 2 in. × 10 in. × 8 ft. clear W. P. sills.
8 pieces ⅞ in. × 4½ in. × 9 ft. out and inside casings.
1 piece ⅞ in. × 4½ in. × 8 ft. inside head casings.
1 piece ⅞ in. × 6½ in. × 8 ft. outside head casings.
1 piece 2½ in. × 3½ in. × 8 ft. }
1 piece 1¾ in. × 3¾ in. × 8 ft. } transom bars.
8 lin. ft. molding. }
2 transoms for above, 2 lights, 10 in. × 14 in.
1 piece 1⅜ in. × 5½ in. × 6 ft. rails.
1 piece 1⅜ in. × 7 in. × 3 ft. stiles and muntins.
11 inside door frames.
11 pieces 3 ft. 2 in. ash molding thresholds.
11 pieces 1⅛ in. × 6 in. × 14 ft. jambs.
3 pieces 1⅛ in. × 6 in. × 12 ft. heads.
22 pieces ⅞ in. × 4½ in. × 14 ft. casings.
11 pieces ⅞ in. × 4½ in. × 8 ft. head casings.
11 pieces 14 ft. molding stops.
3 pieces 12 ft. molding stops.
13 doors, 4 panels raised O. G. 1⅜ × 2 ft. 8 in. × 6 ft. 8 in.
13 pieces 1⅜ in. × 4½ in. × 14 ft. clear W. P stiles.
3 pieces 1⅜ in. × 4½ in. × 9 ft. } top rails.
1 piece 1⅜ in. × 4½ in. × 12 ft. }
3 pieces 1⅜ in. × 8 in. × 9 ft. } lock rails.
1 piece 1⅜ in. × 8 in. × 12 ft. }
3 pieces 1⅜ in. × 10 in. × 9 ft. } bottom rails.
1 piece 1⅜ in. × 10 in. × 12 ft. }
7 pieces 1⅜ in. × 4½ in. × 14 ft. muntins.
7 pieces ⅞ in. × 12 in. × 12 ft. panels.
9 window frames, 12 lights, 10 in. × 16 in., 2 for balanced sashes.
9 pieces ⅞ in. × 6½ in. × 13 ft. pulley stiles.
3 pieces ⅞ in. × 6½ in. × 10 ft. heads.
9 pieces ⅞ in. × 1⅜ in. × 13 ft. } blind stops.
3 pieces ⅞ in. × 1⅜ in. × 10 ft. }
9 pieces 12 ft. } P. F. & Co. molding parting strips.
3 pieces 10 ft. }
9 pieces ⅞ in. × 4½ in. × 13 ft. outside casings.
3 pieces ⅞ in. × 4½ in. × 12 ft. outside head casings.
3 pieces ⅞ in. × 5 in. × 13 ft. stools.
3 pieces ⅞ in. × 4½ in. × 12 ft. aprons.
12 pieces molding stops.
3 pieces ⅞ in. × 5½ in. × 10 ft. subsills.
3 pieces 1¾ in. × 6 in. × 12 ft. sills.
9 pairs 1⅜ in. check-rail sash for frames, 12 lights, 10 × 16.
3 pieces 1⅜ in. × 8½ in. × 10 ft. rails and muntins.
9 pieces 1⅜ in. × 8 in. × 13 ft. stiles and muntins.
3 pieces 1⅛ in. × 4 in. × 10 ft. meeting rails.
6 window frames, 12 lights, 10 in. × 14 in.
6 pieces ⅞ in. × 6½ in. × 11 ft. jambs.
2 pieces ⅞ in. × 6½ in. × 10 ft. heads.
6 pieces ⅞ in. × 1⅜ in. × 11 ft. } blind stops.
2 pieces ⅞ in. × 1⅜ in. × 10 ft. }
6 pieces } P. F. & Co. molding parting strips.
2 pieces }
6 pieces ⅞ in. × 4½ in. × 11 ft. outside casings.
2 pieces ⅞ in. × 4½ in. × 10 ft. outside head casings.
2 pieces ⅞ in. × 5 in. × 12 ft. stools.
2 pieces ⅞ in. × 4½ in. × 12 ft. aprons.
6 pieces 12 ft. } P. F. & Co. molding window stops.
2 pieces 10 ft. }
2 pieces ⅞ in. × 5½ in. × 10 ft. subsills.
2 pieces 1¾ in. × 6 in. × 12 ft. sills.
6 pairs 1⅜ in. check-rail sash for frames, 12 lights, 10 × 14.
2 pieces 1⅜ in. × 8½ in. × 10 ft. rails and muntins.
6 pieces 1⅜ in. × 8 in. × 12 ft. stiles and muntins.
2 pieces 1⅛ in. × 4 in. × 10 ft. meeting-rails.
2 cellar window frames, 3 lights, 10 in. × 14 in.
1 piece 2 in. × 10 in. × 14 ft. } frames.
1 piece 2 in. × 10 in. × 8 ft. }
2 sashes for above, 1⅜ in., 3 lights, 10 in × 14 in.
1 piece 1⅜ in. × 6 in. × 8 ft. rails.
1 piece 1⅜ in. × 8 in. × 4 ft. stiles.

Hardware.

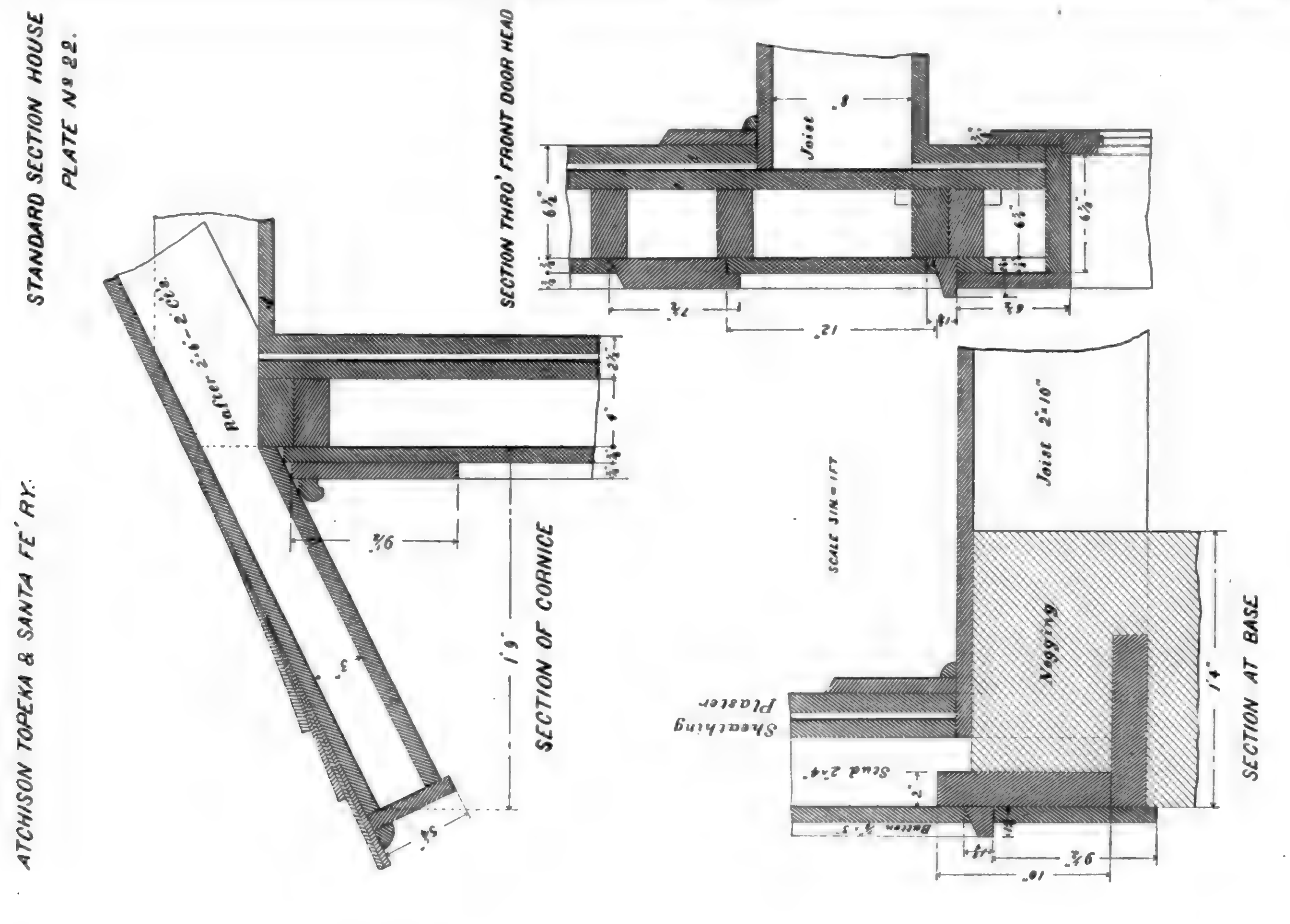
6 lights, glass 10 in. × 14 in. single thick A, cellar windows.
4 lights, glass 10 in. × 14 in. single thick A, transoms.
108 lights, glass 10 in. × 16 in. single thick A, first-story windows.
72 lights, glass 10 in. × 14 in. single thick A, second-story windows.
8 pieces 2 in. axle pulleys, kitchen windows.
2 gross round-headed ⅞-in. wood screws No. 7, window stops.

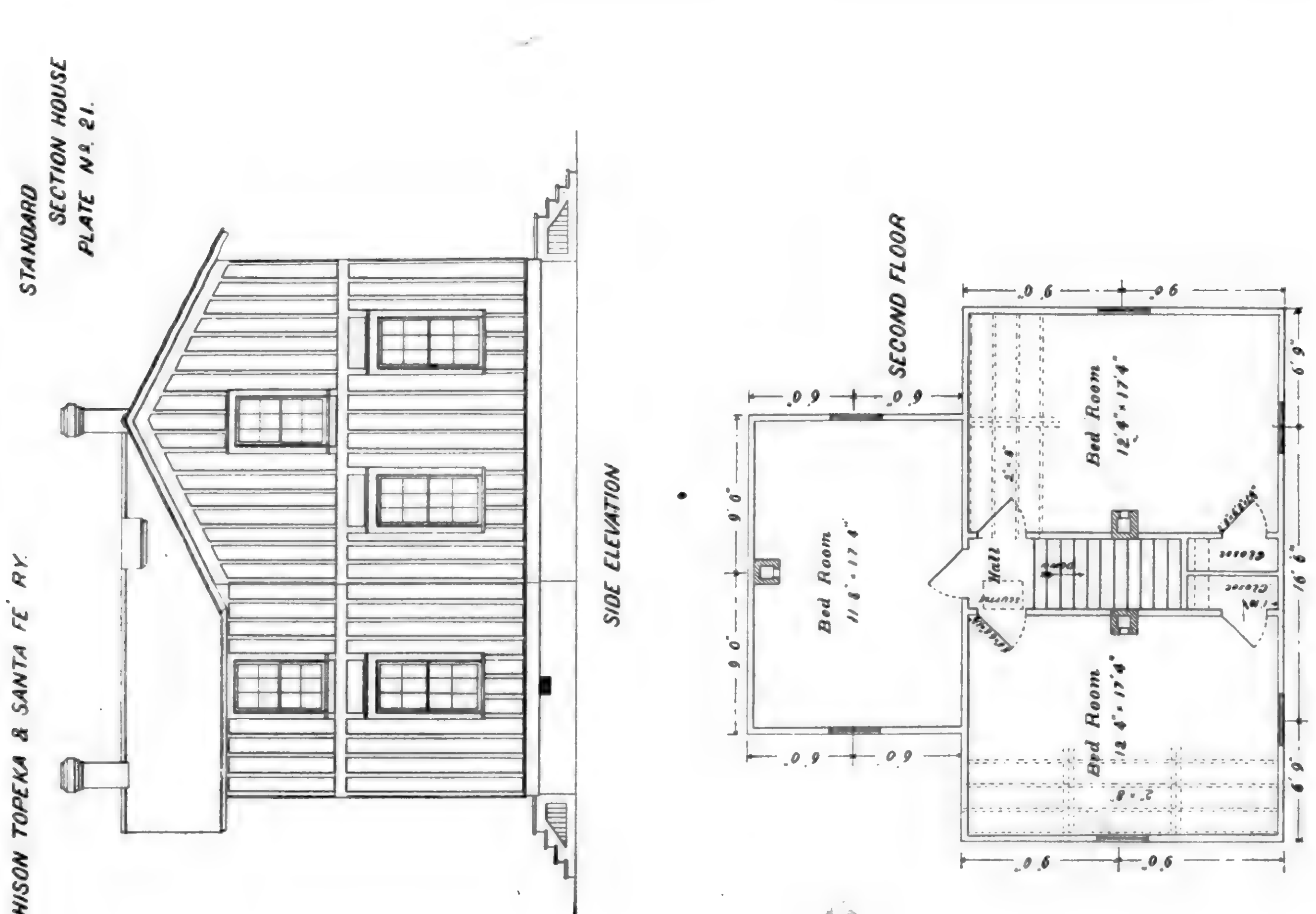


ATCHISON TOPEKA, & SANTA FÉ R.R. STANDARD SECTION HOUSE
PLATE No. 19.



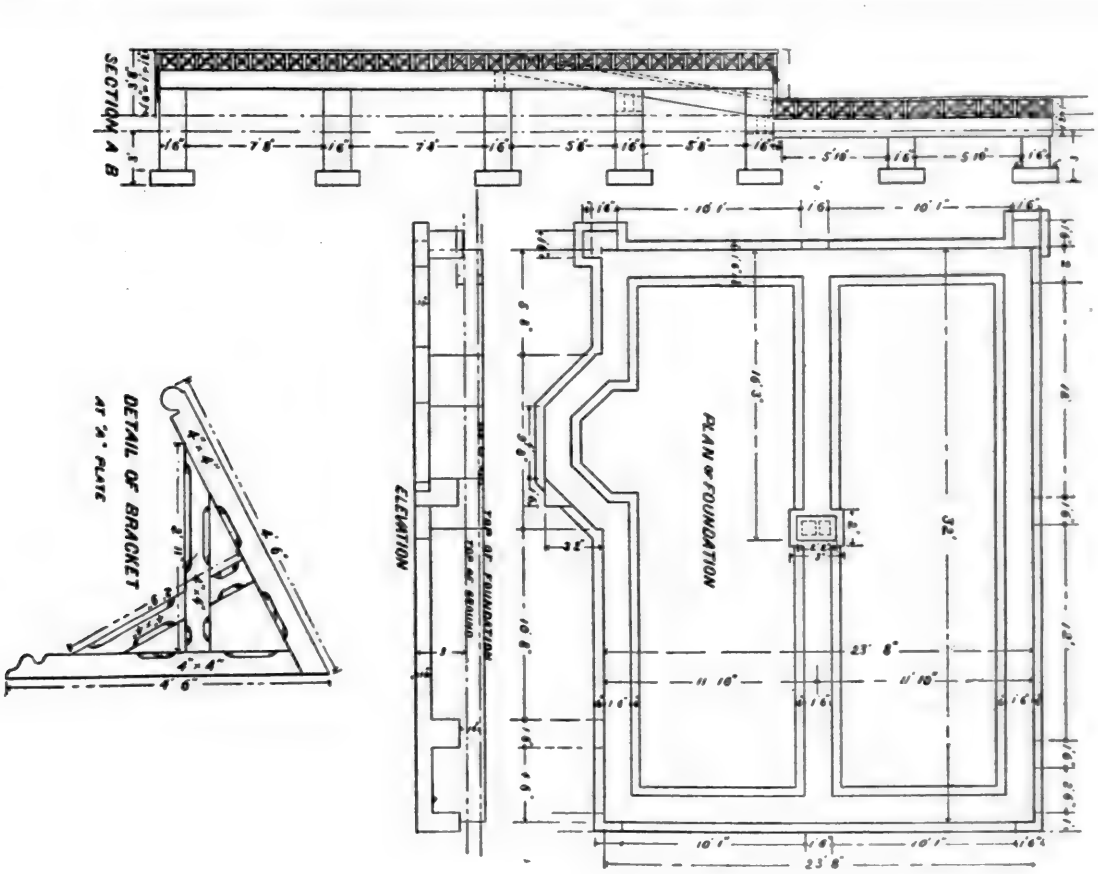
ATCHISON TOPEKA & SANTA FÉ R'Y. STANDARD SECTION HOUSE
PLATE No. 20.


ATCHISON TOPEKA & SANTA FE' RY.
STANDARD SECTION HOUSE
PLATE Nº 22.
SECTION THRO' FRONT DOOR HEAD
Joist
SECTION OF CORNICE
Joist 2"×10"
Nogging
Sheathing
Plaster
Stud 2"×4"
SECTION AT BASE


ATCHISON TOPEKA & SANTA FE' RY.
STANDARD
SECTION HOUSE
PLATE Nº 21.
SIDE ELEVATION
SECOND FLOOR
Bed Room
Bed Room
Bed Room
Hall
Closet
Closet

ATCHISON TOPEKA & SANTA FE RY.

STANDARD DEPOT, 24'×60'.
PLATE No. 24.



SECTION A B

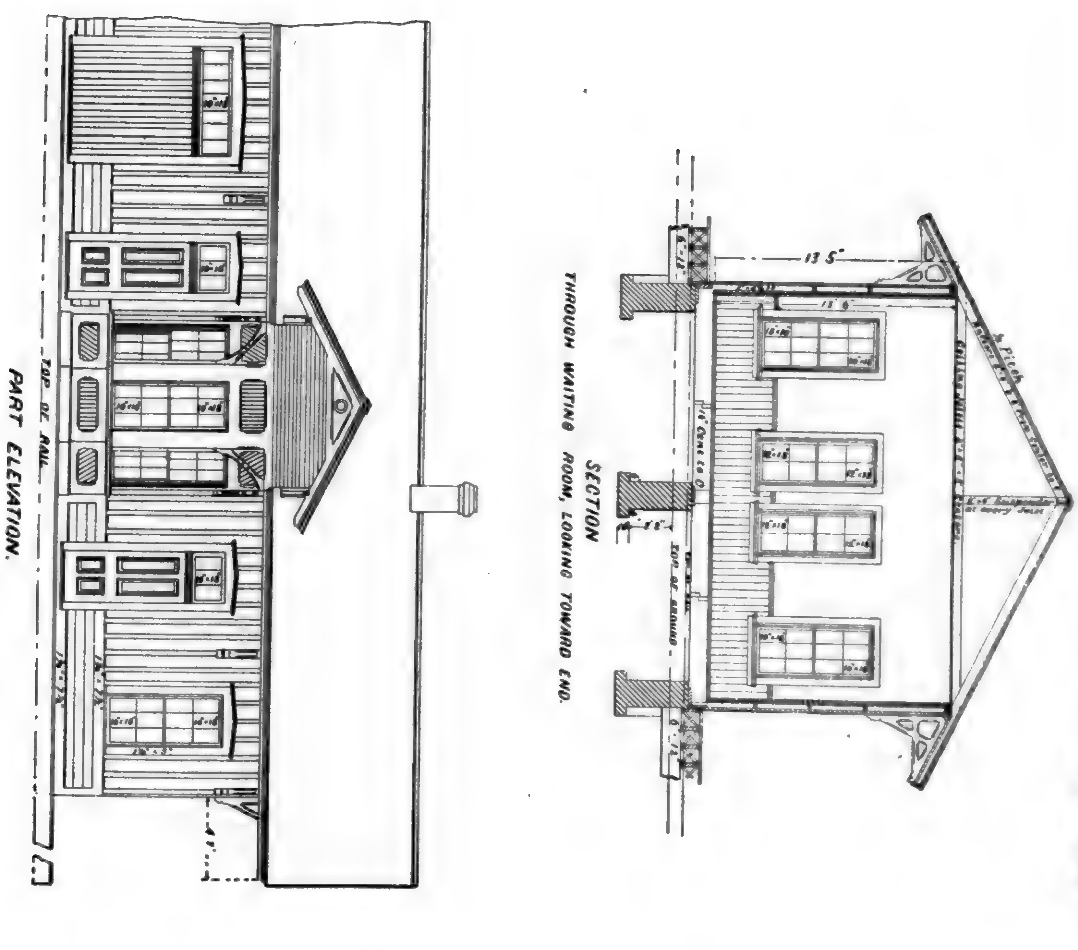
PLAN & FOUNDATION

ELEVATION

DETAIL OF BRACKET AT 'A' PLATE

ATCHISON TOPEKA & SANTA FE RY.

STANDARD DEPOT, 24'×60'.
PLATE No. 23.

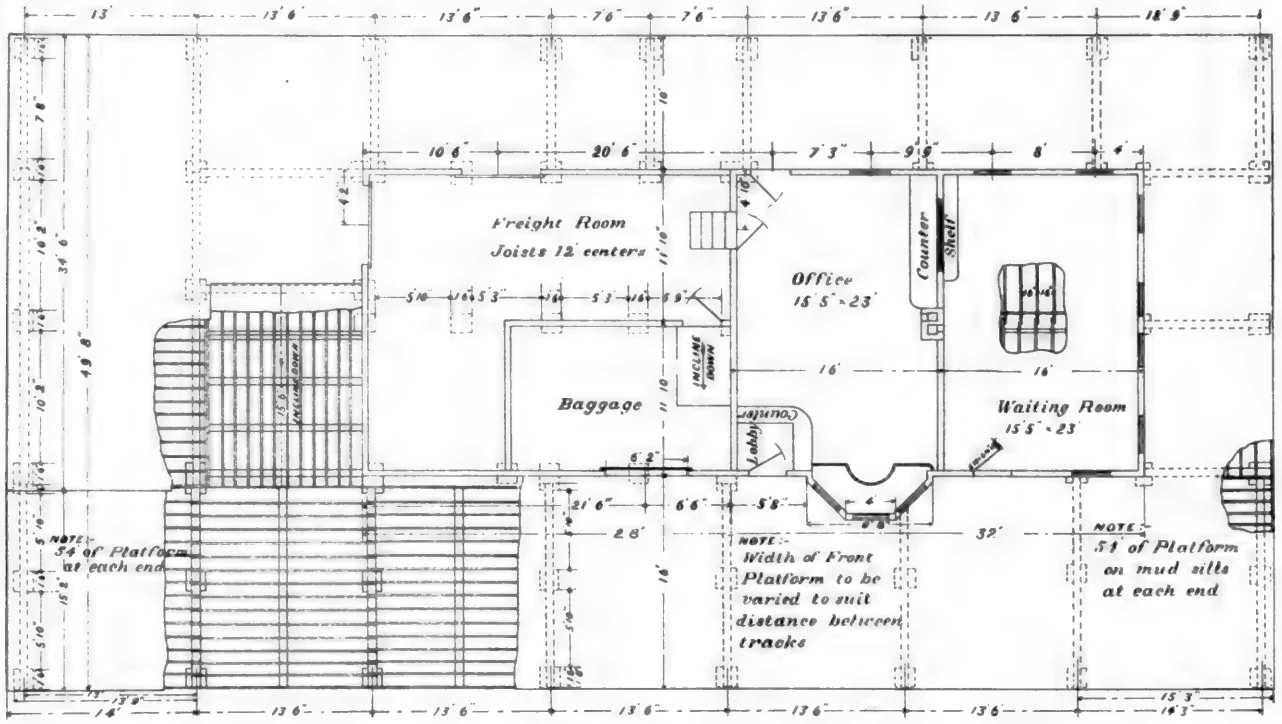


SECTION THROUGH WAITING ROOM, LOOKING TOWARD END.

PART ELEVATION.

STANDARD DEPOT.
PLATE No. 25.

ATCHISON TOPEKA & SANTA FE RY.



PLAN

10 lbs. 8 d. nails, common.
50 lbs. 10 d. nails, common.
10 lbs. 8 d. nails, finishing.
10 lbs. 10 d. nails, finishing.
2½ galls. boiled oil.
25 lbs. white lead.
⅛ gross No. 1 sand-paper.
⅛ gross No. 2 sand-paper.
50 lbs. putty.
15 gross glazier points.

Lumber.

36 pieces 2 in. × 10 in. × 18 ft. first-floor joists.
280 lin. ft. 2 in. × 10 in. common sills.
100 pieces 2 in. × 4 in. × 18 ft. studding exterior wall.
26 pieces 2 in. × 4 in. × 18 ft. (cut) first-story partition.
16 pieces 2 in. × 4 in. × 16 ft. (cut) second-story partition.
1,030 lin. ft. 2 in. × 4 in. plates, lookouts, girts, etc.
36 pieces 2 in. × 8 in. × 8 ft. second-floor joists.
35 pieces 2 in. × 6 in. × 18 ft. ceiling joists.
46 pieces 2 in. × 6 in. × 12 ft. rafters.
2 pieces 2 in. × 6 in. × 18 ft. valley rafters.
60 lin. ft. 2 in. × 6 in. × 12 ft. ridge pieces.
1,200 ft. B. M. s.l.s. common roof sheathing.
2,600 ft. B. M. s.l.s. common interior sheathing.
8 pieces ⅞ in. × 5½ in. × 12 ft. ledger.
10,000 * A shingles.
10 pieces ⅞ in. × 5⅛ in. × 12 ft. ridge boards.
9,500 laths.
290 ft. B. M. ⅞ in. yellow-pine flooring, kitchen and pantry.
1,700 ft. B. M. ⅞ in. white-pine flooring.
450 lin. ft. 1 in. × 3 in. crossbridging.
320 ft. B. M. ⅞ in. selected fence flooring plancher.
9 pieces ⅞ in. × 5¼ in. × 12 ft. } facia.
3 pieces ⅞ in. × 5¼ in. × 14 ft. }
9 pieces 12 ft. } P. F. & Co. molding crown mold.
3 pieces 14 ft. }
12 pieces 12 ft.
12 pieces ⅞ in. × 9½ in. × 12 ft. frieze.
4 pieces ⅞ in. × 9½ in. × 12 ft. outside base.
8 pieces ⅞ in. × 9½ in. × 10 ft. outside base.
4 pieces 1¾ in. × 1¾ in. × 12 ft. outside base waterdrip.
8 pieces 1¾ in. × 1¾ in. × 10 ft. outside base waterdrip.
90 pieces ⅞ in. × 12 in. × 10 ft. C. stock first-story siding.
10 pieces ⅞ in. × 12 in. × 10 ft. C. stock second-story siding.
29 pieces ⅞ in. × 12 in. × 14 ft. C. stock second-story siding.
6 pieces ⅞ in. × 12 in. × 16 in. C. stock second-story siding.
6 pieces ⅞ in. × 12 in. × 18 ft. C. stock second-story siding.
12 pieces ⅞ in. × 12 in. × 10 ft. C. stock second-story siding.
3 pieces ⅞ in. × 12 in. × 16 ft. C. stock second-story siding.
33 pieces ⅞ in. × 3 in. O. G. 14 ft. }
9 pieces ⅞ in. × 3 in. O. G. 16 ft. }
6 pieces ⅞ in. × 3 in. O. G. 18 ft. } batten.
2 pieces ⅞ in. × 3 in. O. G. 12 ft. }
112 pieces ⅞ in. × 3 in. O. G. 10 ft. }
130 lin. ft. 1¾ in. × 7½ in. × 12 ft. and 10 ft. long, band.
350 ft. B. M. ⅞ narrow beaded ceiling, wainscot.
344 lin. ft ⅞ in. × 7⅛ in. beveled base.
4 pieces ⅞ in. × 12 in. × 12 ft. pantry shelves.
344 lin. ft. P. F. & Co. molding base mold.
3 pieces ⅞ in. × 4½ in. × 12 ft. panel finish between first and second story.
4 pieces 1¾ in. × 2¼ in. × 12 ft. waterdrip over windows and doors.
1 piece 2 in. × 8 in. × 10 ft. scuttle trimming.
1 piece 1¾ in. × 3¼ in. × 10 ft. scuttle batten.
2 pieces 2 in. × 10 in. × 10 ft. outside stair stringers.
1 piece 4 in. × 10 in. × 10 ft. mudsill.
2 pieces 2 in. × 6 in. × 10 ft. stairs trimming.
2 pieces 2 in. × 4 in. × 12 ft. stairs trimming.
30 ft. B. M. narrow beaded ceiling, panels outside stairs.
4 pieces 1¾ in. × 11½ in. × 14 ft. treads.
3 pieces ⅞ in. × 7½ in. × 14 ft. risers.
2 pieces 2 in. × 12 in. × 12 ft. cellar stairs stringers.
4 pieces 2 in. × 10 in. × 12 ft. cellar stairs treads.
1 piece 4 in. × 12 in. × 4 ft. cellar stairs mudsill.
3 pieces 2 in. × 12 in. × 14 ft. first-floor stair stringers.
5 pieces 1¾ in. × 10 in. × 12 ft. first-floor stair treads.
5 pieces ⅞ in. × 8½ in. × 12 ft. first-floor stair risers.

Water Closet and Fencing.

7 pieces 2 in. × 12 in. × 16 ft. sides of cesspool.
7 pieces 2 in. × 12 in. × 10 ft. ends.
4 pieces 2 in. × 4 in. × 7 ft. corners.
2 pieces 2 in. × 4 in. × 8 ft. sills.
2 pieces 2 in. × 4 in. × 6 ft. sills.
1 piece 2 in. × 10 in. × 6 ft. floor joists under partition.
48 ft. B. M. 2 in. plank 8 ft. flooring.
15 pieces 2 in. × 4 in. × 8 ft. studding.
2 pieces 2 in. × 4 in. × 16 ft. girts.
2 pieces 2 in. × 4 in. × 8 ft. plates.

2 pieces 2 in. × 4 in. × 6 ft. plates.
6 pieces 2 in. × 4 in. × 8 ft. rafters.
12 pieces ⅞ in. × 12 in. × 10 ft. C. stock siding.
16 pieces ⅞ in. × 12 in. × 9 ft. C. stock siding.
24 pieces 3 in. O. G. battens, 18 ft.
12 pieces ⅞ in. × 12 in. × 18 ft. D. stock lining.
80 ft. B. M. D. stock 10 ft. roof boards.
600 * A shingles.
2 pieces 3 in. crown mold, 18 ft.
2 ventilators.

Fencing.

49 pieces cedar posts, 5 in. diameter at small end.
130 pieces 1 in. × 6 in. × 16 ft. rough fencing boards.

Walk to Privy.

180 ft. B. M. ⅞ in. × 18 ft. fencing.
120 lin. ft. 2 in. × 4 in.

Hardware.

50 lbs. 3 d. shingle nails.
65 lbs. 3 d. fine lath nails.
2 kegs 20 d. nails, common.
1 keg 10 d. nails, common.
¾ keg 8 d. nails, common.
40 lbs. 10 d. nails, finishing.
17 lbs. 8 d. nails, finishing.
25 lbs. 6 d. nails, finishing.
1¼ gross 1½ in. wood screws No. 10.
2 gross 1 in. wood screws No. 10.
250 yds. plain building paper.
3 galls. shellac varnish.
4 galls. turpentine.
8 lbs. putty.
2 lbs. drop black.
4 pairs 3 in. × 3 in. wrought butts, transoms and cellar windows.
4 pieces spring catches, transoms and cellar windows.
1 pair 4 in. × 4 in. wrought butts, scuttle.
1 6-in. hinged hasp and staple, scuttle.
8 pieces sash weights, 6¾ lbs. each, kitchen windows.
50 lin. ft. ¼ in. white Silver Lake sash cord No. 8.
2 pieces Berlin bronzed sash locks.
52 pieces window spring bolts.
104 pieces window sockets.
2 pieces 5-in. hooks with 2 eyes, cellar windows.
13 pairs 3½ in. × 3½ in. loose pin cast butts, doors.
13 thumb latches.
2 pieces right-hand rim night latches.
1 piece left-hand rim night latches.
28 lin. ft. 14 in. continuous I. C. flashing tin, scuttles and chimneys.
34 lin. ft. 20 in. continuous I. C. gutter tin, valleys.
6 sq. ft. roofing tin I. C. (2 ft. × 3 ft.), scuttle.
3 pieces soot drawers, 6 in. × 8½ in. × 13 in.
4 doz. wardrobe hooks.
3 pieces ventilating grates.
5 lbs. 8 d. clinch nails.
5 pieces terra-cotta stovepipe thimbles, 6 in. × 4½ in.
2 pieces terra-cotta stovepipe thimbles, 6 in. × 9 in.
60 galls. mineral paint.
20 galls. boiled oil.
75 lbs. white lead.
3 cast-iron chimney caps.

Water Closet and Fencing.

10 lbs. 20 d. common nails.
10 lbs. 10 d. common nails.
6 lbs. 8 d. common nails.
4 lbs. 3 d. shingle nails.
3 lbs. 8 d. clinch nails.
2 pairs 3 in. × 3 in. wrought butts, with screws.
2 thumb latches.
1 night lock.
8 ft. ¼ in. × 1 in. bar-iron for ventilator.

Fence.

25 lbs. 8d. fencing nails.
2 pieces 6 in. strap hinges and screws.
1 St. Louis gate latch.
10 galls. mineral paint.
2½ galls. boiled oil.
1 set Western gate hinges.

Privy Walk.

5 lbs. 8 d. common nails.

Limes, Cements, etc.

20 bbls. white lime.
2½ bbls. plaster of Paris.
20 bush. plastering hairs.
2 bbls. common lime.
25 bbls. cement.
2,200 bricks.

CHAPTER X.

SMALL STATIONS.

In regard to the plans for STATION-HOUSES, we take up only smaller wooden stations, for the reason that the larger ones, such as are built in cities and towns of any importance, are usually put into the hands of professional architects, and do not properly come within the scope of the railroad engineer.

Plates Nos. 23, 24 and 25 show the standard 24 × 60 ft. station of the Atchison, Topeka & Santa Fé Railroad. There are no bills of material given with these plans, from the fact that the dimension of every piece of timber required is noted on the plan, and also that every detail is given in a larger scale, so that for any particular case it would require very little work for the engineer to make out a bill of material which would answer for the occasion, and any one bill of material that could be made out, and that would answer for any one particular locality, would probably, for local reasons, not be the most economical that could be used in some other.

Some general remarks on stations, and some additional plans for small station-houses, are necessarily deferred to the next chapter.

(TO BE CONTINUED.)

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 238.)

CHAPTER XXVII.

WATER-TANKS AND TURN-TABLES.

QUESTION 716. *How are locomotive tenders or tanks supplied with water?*

Answer. At suitable places, called *water stations,* along the line of the road, large tanks or reservoirs, *H H*, fig. 415, are located, which are filled either from natural streams which are higher than the tanks and thus flow into the latter, or else the water is pumped in, either by hand or by horse, wind, water, or steam power. When there is room for them, these tanks are usually located near the track, as shown in fig. 415, so that the water can be conducted by a spout, *a*, direct from the tank to the man-hole of the tender, *T*. Communication to and from this spout is opened and closed by a valve, *b*, inside of the tank, which is moved from the tender by a rope, *e*, connected to a lever, *f*, and to the valve, *b*. The spout is usually attached to the tank by a hinged joint, so that it can be lowered to the tender and then raised up out of the way of the engine and train. It is generally balanced by a counterweight, suspended to one end of a rope, *d*, which passes over a pulley and is fastened to the spout at the other end. The tanks are now generally made of wooden staves like a tub or pail, and supported on a heavy frame, *c c c*, made of wood, as shown in the engraving, or on stone or brick masonry.

When there is no room for the tank or reservoir near the track, it is placed in any convenient position at some distance from it, and the water is then conveyed by an underground pipe to the place where the locomotive must take water. At the end of this pipe what is called a *stand-pipe* or *water-crane*, fig. 416,* is located. This consists of a vertical pipe, *A*, with a horizontal arm, *B*, which is made so as to swing around over the man-hole of the tender when the latter is to be filled with water. In some cases the horizontal arm alone swings around, but in others the vertical pipe turns with the horizontal one in a joint, *C*, underneath the surface of the ground. The latter plan is thought to be preferable to the first, as the pipe is less

* The engraving illustrates a stand pipe, made by the Sheffield Velocipede Car Co., of Three Rivers, Mich.

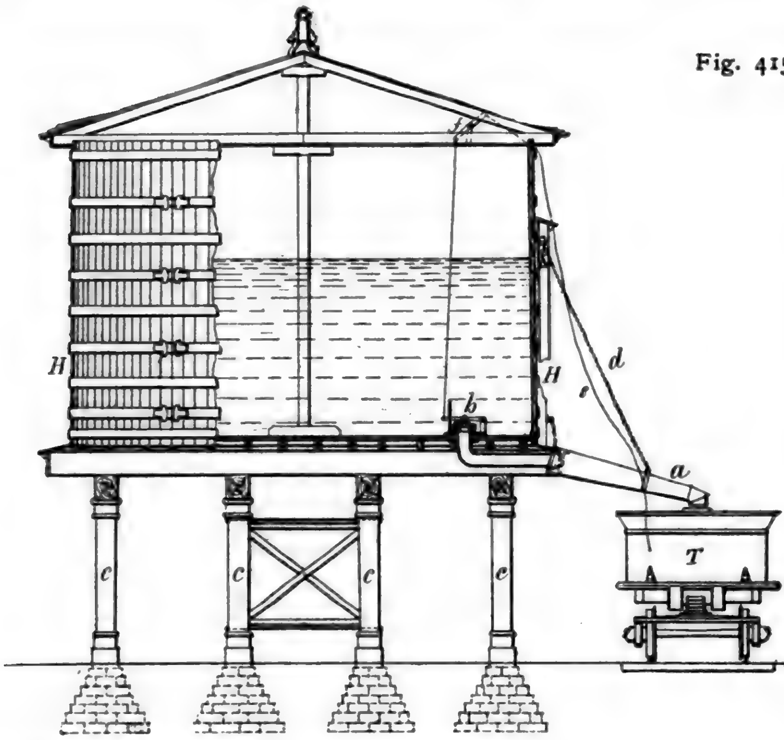


Fig. 415.

liable to freeze fast in the joint when the latter is underground than when it is exposed above. A suitable valve, *D*, is also attached to the pipe below ground, so that the stream of water can be turned off or on at pleasure by the lever *E*, which is connected by rods to the valve.

QUESTION 717. *What effect does the use of impure water have on a locomotive boiler?*

Answer. The use of impure water, or that which contains a considerable amount of mud or solid matter mixed with it, or in suspension, as it is called, or has lime or other mineral substances chemically combined with it, will very soon coat the inside of the boiler with a covering of scale, which is a very bad conductor of heat, and consequently the boiler is much less efficient and much more heat is wasted than if the heating surfaces were clear. Besides this loss of efficiency, when boiler plates are covered with non-conducting scale, they are much more liable to be injured by the action of the fire than when the water comes directly in contact with the metal of the plates. Some water, too, has a corroding effect on the metal of the boiler which is very destructive.

QUESTION 718. *What considerations should determine the source from which a supply of water should be drawn?*

Answer. The first must of course be its convenience to the point where the water is to be used; but more attention should be given to the quality of the water than it ordinarily receives. The location where a water-tank must be having been decided upon, every possible available source of supply should be sampled, and analysis made of each of the samples and the corrosive substance which it contains, and the solid residue which is left after the water is evaporated should be determined. This having been done, the source which contains the least corrosive or scale-making material should be chosen. In general running streams are much better than any other sources. Wells very rarely are good sources of supply. Much expense can be saved in boiler repairs and in the fuel account by a little judicious expenditure of money to secure a supply of good water. On many of the older railroads an examination of all possible sources of water-supply is now being made, with a view to abandoning a large number of the old sources, and securing others near by which contain much less scale-making material. If this had been done when the roads were first located, much extra cost for fuel and repairs would have been saved.

QUESTION 719. *How can the relative amount of incrustating substances in different kinds of water be determined?*

Answer. The relative quantity of solid matter or mud which is held in suspension can be at least approximately determined by simply filling vessels, say large clear glass bottles, with different kinds of water and adding a few drops of water of ammonia, and letting them stand for some time until the solid matter settles to the bottom.

A comparison of one water with another, as to its scale-making properties, may readily be obtained by having samples of the different waters in some small bottles of the same size, adding to them water of ammonia until each is distinctly alkaline, and then a little phosphate of soda. This causes a precipitation of the iron, alumina, lime, and magnesia in the water as phosphates, and the bulk of the precipitate indicates the relative amount of scale-making material. This test is, of course, crude, and would hardly take the place of a good chemical analysis, but it is much better than nothing.

When the water of ammonia cannot easily be procured, an experiment may be tried, in the same way, by dissolving common white soap, or other pure soap, in a goblet of pure water, and then stirring into the glasses of water to be tested a few teaspoonfuls of this solution. The comparative amount of scale-making material in the water will be shown by the amount of coagulated matter which will be thrown down.

QUESTION 720. *What are the most commonly occurring corrosive materials in waters used in boilers?*

Answer. The most commonly occurring corrosive materials are sulphates of iron and alumina and chloride of magnesium. The former are universal constituents of mine drainage. The latter occurs most frequently along the sea-shore. In addition to this many waters which drain from mines contain

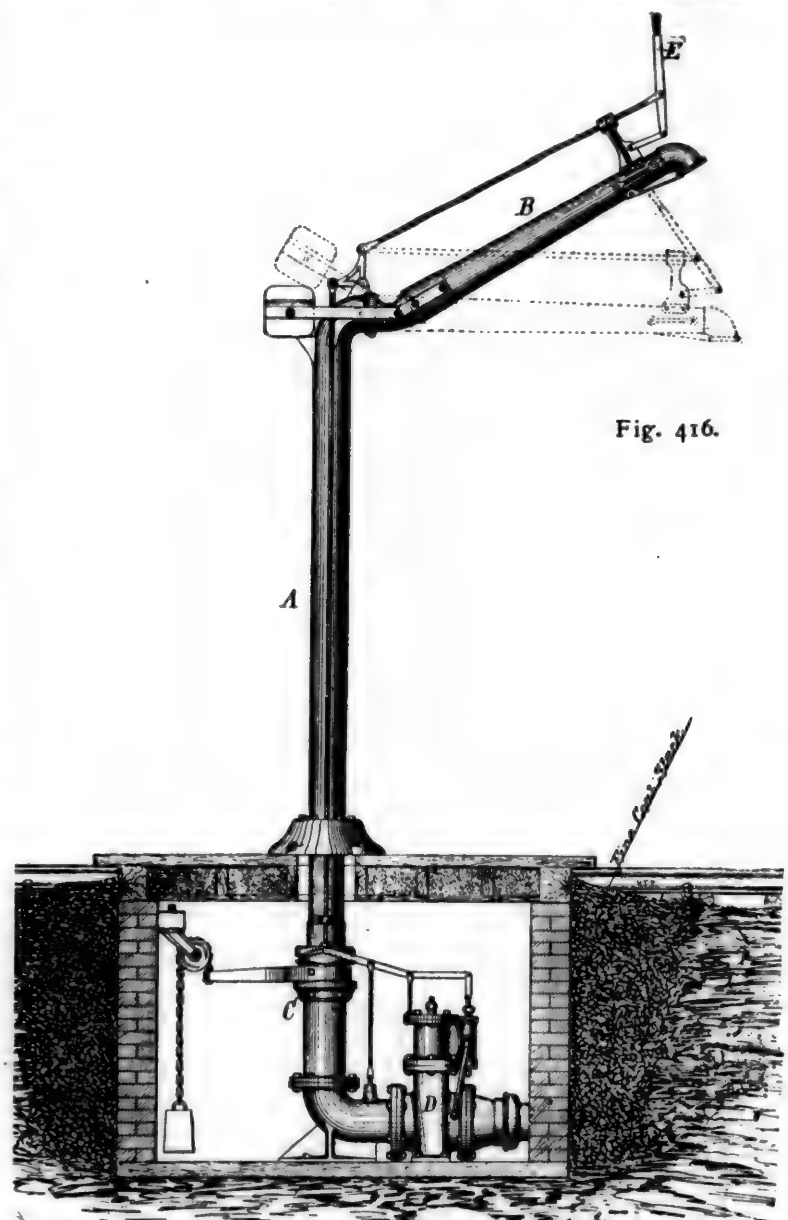


Fig. 416.

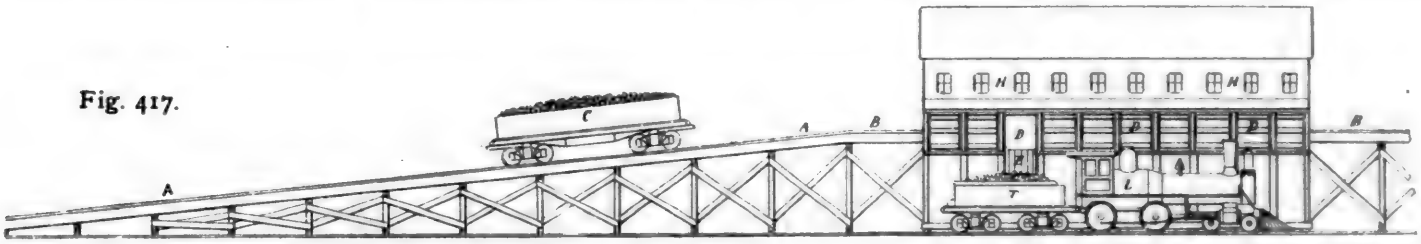
large amounts of free sulphuric acid. If any mine drainage gets into the water-supply at any place, the use of that water should be abandoned if possible. Also in wells along the seashore, or on the banks of rivers affected by the tides, chloride of magnesium is a frequent constituent, and often causes serious corrosion of boilers.

QUESTION 721. *How are locomotive tenders supplied with coal?*

Answer. This is done in a variety of ways. Sometimes the coal is shoveled from cars alongside of the tender, but this is a slow and laborious method. In other cases iron buckets are filled with coal at stations and then are hoisted by cranes and swung over the tenders. They are then either tipped or a door in the bottom is opened and the contents are emptied into the tender. In still other cases, small cars are loaded with coal and are run on platforms which are high enough, so that the contents of the cars can be dumped into the tender. Fig. 417 represents a side view and fig. 418 a transverse section of what is called a *coal chute.** It consists of an inclined track, *A A*, which leads to an elevated level track, *B B*, in a building, *H H*. On one or both sides of this track the building has receptacles or "pockets," as they are called, *F*, fig. 418, to receive the coal from the cars. These pockets have inclined floors, *G*, and are closed by doors, *D D*, figs. 417 and 418. Each pocket also has a spout or "*apron,*" *E*, which can be extended out over the tender, as shown in fig. 418. These aprons are hinged at *I*, and can be folded up out of the way when not in use. The pockets are filled with coal, and when a tender, *T*, is to be supplied it is run on a track alongside of the coal chute opposite to one of the pockets. The apron, *E*, is then lowered and the door *D* opened, and the contents of the pocket are emptied into the tender in a few seconds.

In some cases coal chutes are furnished with scales for weighing the coal supplied to tenders.

Fig. 417.



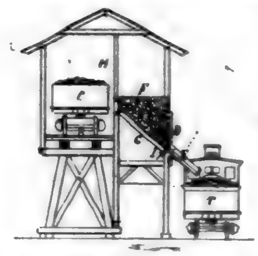


Fig. 418.

QUESTION 722. *How are locomotives turned around on the track?*

Answer. The most common means employed for that purpose is a *turn-table,* of which fig. 419 is a side elevation, fig. 420 a plan, and fig. 421 a cross-section through the center on the line *a b*.† It consists of two heavy beams or girders made of wood, cast or wrought iron, placed side by side and resting on a pivot, *P*, fig. 421, in the center, on which they turn. They are placed in a circular pit, *C C* (part of which is omitted in the plan), below the level of the track, *A A*, so that when rails are laid in the ordinary way on top of the girders they will be exactly level with the track which leads up to the pit. By turning the girders on the central pivot so that the rails will come exactly in line with the permanent track which leads up to the pit, the locomotive can be run on the turn-table, which is then revolved a half-revolution, which of course reverses the position of the locomotive and brings it opposite the permanent track so that it can be run off from the table. In order to prevent the girders from tipping down when the engine first runs on or off of the turn-table, wheels, *W W*, are placed at their outer ends which run on a circular track, *D D*, and they bear any inequality of weight that may be thrown on them if the locomotive is not equally balanced on the central pivot.

QUESTION 723. *How is the central pivot constructed?*

Answer. It usually consists of a vertical post, *F* (shown in fig. 421, which is a transverse section through the center of the turn-table), the end of which has a hard cast-iron or steel bearing. In some cases, the weight rests on conical steel rollers, which revolve in a circular path formed in the top plates. Sometimes turn-tables are fitted with gearing and cranks, but if they are made so that the whole weight rests on the center, and if they are of sufficient length so that an engine and tender can be moved on them sufficiently to be balanced over the center, gearing will not be needed; but a simple lever fastened to the turn-table will be all that will be required to turn the table and the engine and tender on it. The tables should be of such a diameter or length across the center as will enable the class of engine in use on any road to be balanced. With light engines a table 50 ft. in diameter is large enough; with the long, heavy engines now used on the great trunk lines, an engine and tender quite fill up the entire length of 50 ft., leaving no margin for adjustment. In such cases a table 60 ft. in diameter should be employed. These large tables are also made heavier in proportion. When the engine

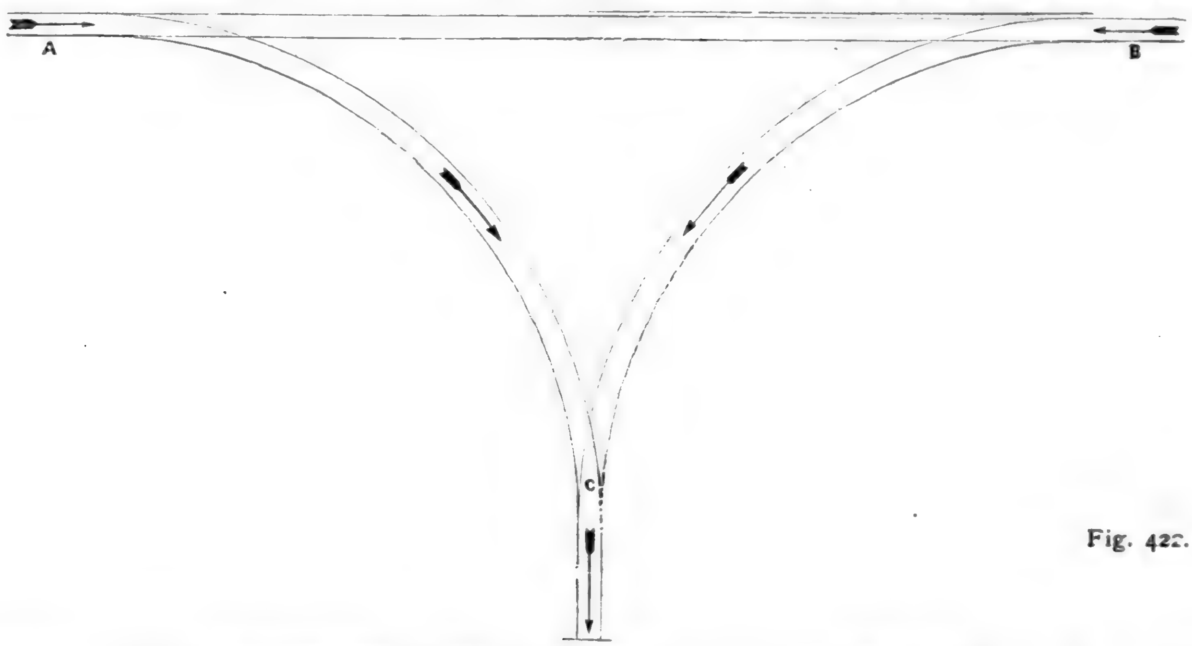


Fig. 422.

* The figures represent a coal chute made and patented by Williams, White & Co., of Moline, Ill.

† Designed by A. P. Boller, C.E., 71 Broadway, New York.

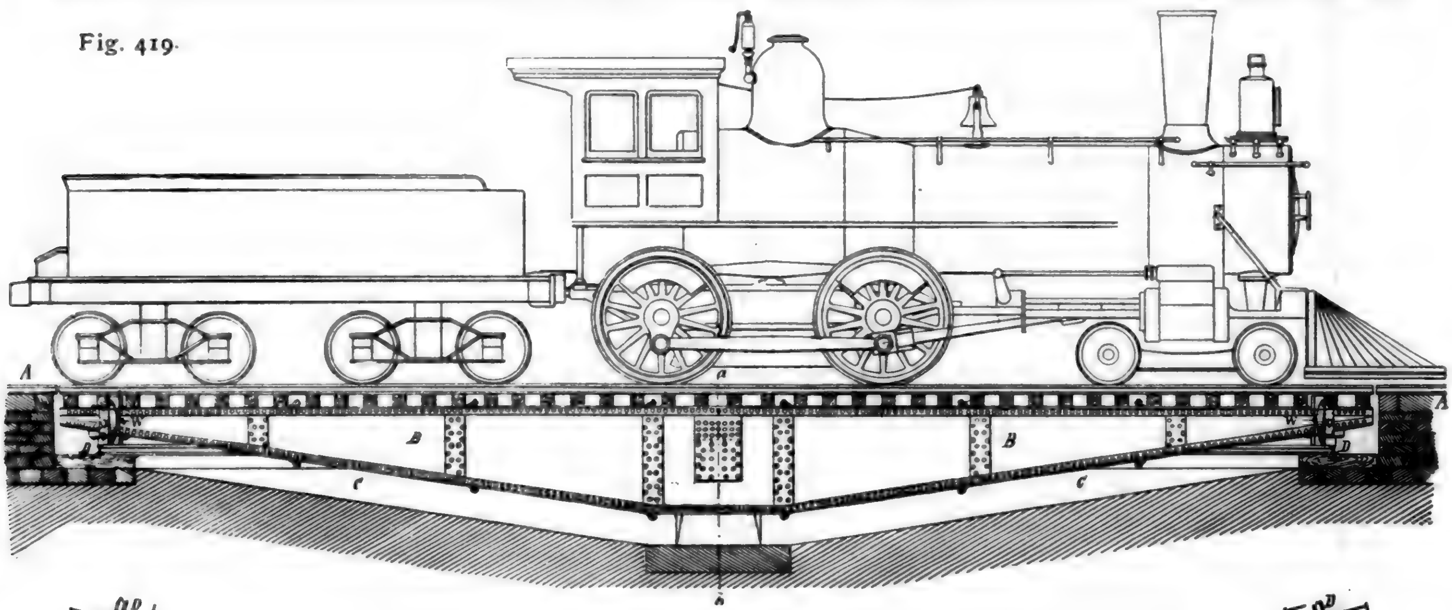


Fig. 419.

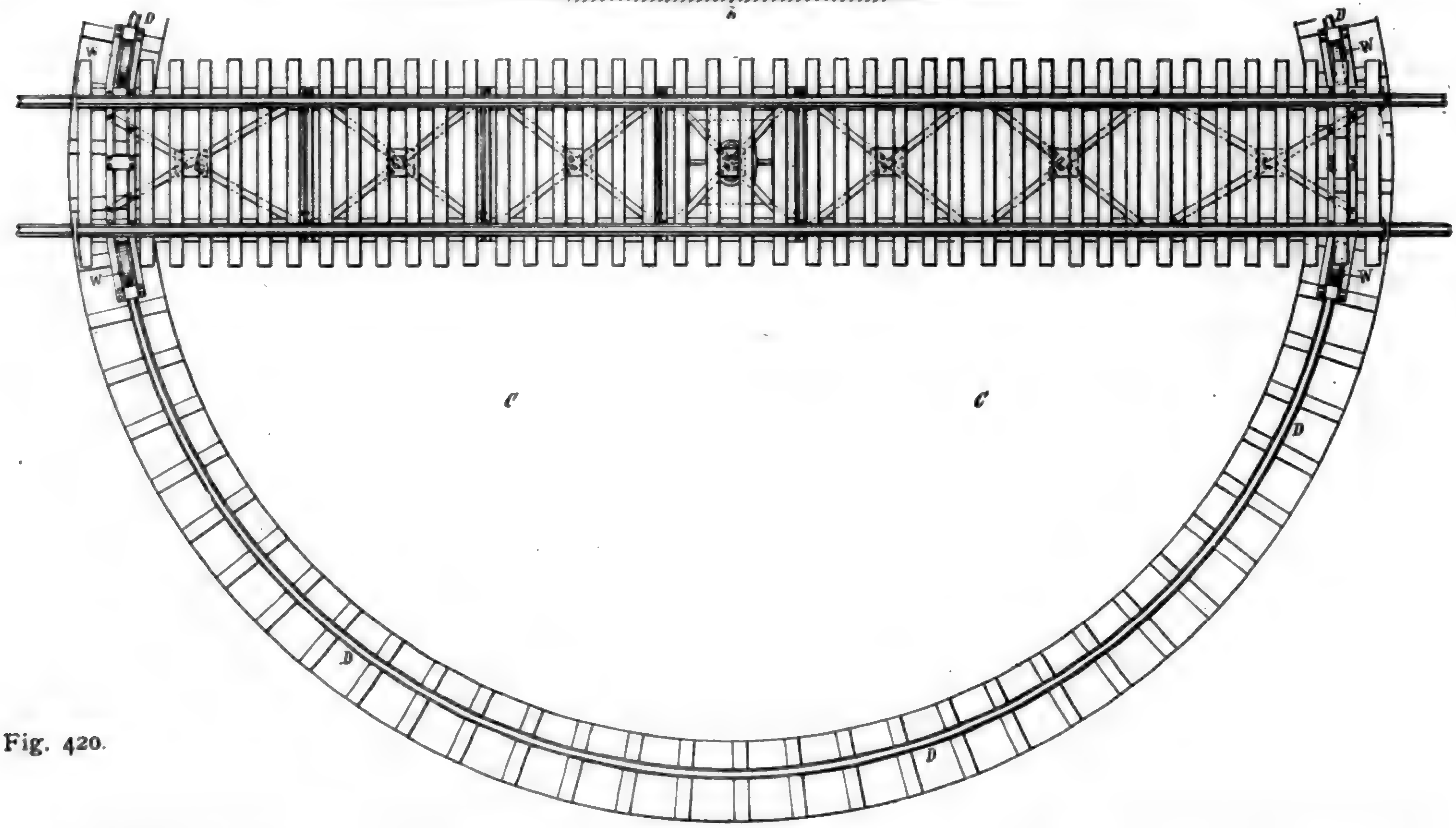


Fig. 420.

and tender is balanced over the center pivot, one man can turn the loaded table with ease.

In setting up turn-tables it is necessary that the foundation at center, upon which the pivot rests, should be of the most substantial character, so as not to be liable to settle. The circular track, which may be made of light rails, say 28 or 30 lbs. to the yard, should be level, and the table should be so adjusted as to swing clear of the circular track when loaded. The pit required is quite shallow near the edge and deepens toward the center, and should be properly drained to prevent water from standing in it. Provision is made for covering the entire pit by a platform turning with the table, but this should be avoided whenever possible, as the best-constructed cover does offer some resistance in turning. Even in roundhouses, where a covered pit might be considered preferable as presenting a smooth floor for crossing in any direction, it has been found advisable, in view of the greatest ease in turning and the facility offered by the open pit for cleaning, to dispense with the cover. The center of the table must be kept clean and well oiled, say with best sperm or lard oil and tallow of such a consistency as not to harden in cold weather. The top cap at center is held in place by bolts, *G G*. These bolts take the entire weight of the table and load; by slacking off the bolts the table can be lowered on the wheels on the circular track and the cap lifted off to gain access to the bearings. This should be opened, examined and cleaned at least once every three months.

QUESTION 724. *Is there any other method of turning locomotives?*

Answer. Yes; what is called a **Y** is sometimes used. This

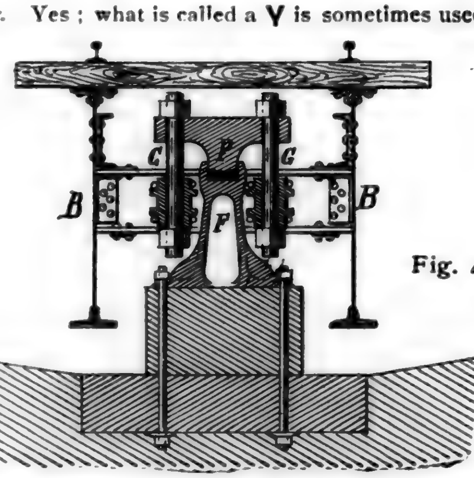


Fig. 421.

consists of a system of tracks laid somewhat in the form of the letter **Y**, as shown in fig. 422, in which *A B* is the main track, with two curves, *A C* and *B C*, laid as shown. If it is de-

sired to turn a locomotive which is standing in the position of the dart *A*, it is run on the curve *A a C* to the position of the darts *a* and *C*. It is then run backward from *C* on the curve *C b B*, as represented by the dart *b*, and when it reaches the main track in the position of the dart *B* it is evident that its position will be reversed, as is shown if we compare the direction of the dart *A* with that of *B*.

CHAPTER XXVIII.

PERFORMANCE AND COST OF OPERATING LOCOMOTIVES.

QUESTION 725. *What are the elements of cost of operating locomotives?*

Answer. They are (1) the cost of fuel; (2) of the service or wages of the engineer and fireman; (3) of lubricating and illuminating oil, waste, and miscellaneous supplies; (4) of repairs to the engine and tender, and (5) cleaning and watchmen.

QUESTION 726. *In what way may the cost of operating locomotives be counted and compared?*

Answer. The cost is usually counted at so much per train mile or per car mile.

QUESTION 727. *What is the usual cost of these items of expense?*

Answer. The cost per train mile, of course, varies very much with the loads hauled, the speeds, grades, condition of the road, weather, price of coal, etc. The following table, taken from one of the monthly performance sheets of the Lake Shore & Michigan Southern Railroad, gives the cost per train mile for the different classes of trains:

COST OF LOCOMOTIVE SERVICE.

Kind of Train.	Cost per Train Mile.					
	Fuel, Cents.	Wages, Cents.	Oil Waste, etc., Cents.	Repairs, Cents.	Cleaning and Watchman, Cents.	Total, Cents.
Passenger...	4.27	6.61	.05	3.77	.21	14.91
Freight.	6.43	6.61	.05	3.33	.21	16.63
Working....	2.86	6.61	.05	2.03	.21	11.76
Switching...	2.57	6.61	.05	2.19	.21	11.63
Average.....	4.94	6.61	.05	3.15	.21	14.96

The Lake Shore line has no very steep grades, and consequently its engines are not so heavy as on some other lines. On the Pennsylvania Road, for example, which has steep grades and heavy engines, the average cost of repairs in 1887 was 6.43 cents per train mile, or more than double that on the Lake Shore line, for the month quoted.

QUESTION 728. *What proportion do the locomotive expenses bear to the total cost of operating a railroad?*

Answer. In 1888, on the Lake Shore Railroad, the expenses named in the table were nearly 15 per cent. of the total operating expenses.

QUESTION 729. *How much coal is consumed per mile by a locomotive and tender without a train?*

Answer. No very reliable experiments have been made with large engines to determine this, but in some experiments which were reported to the Master Mechanics' Association in 1876,* it was shown that the coal consumed in running an engine and tender, the total weight of which was about 50 tons, over a road without a train at an average speed of between 20 and 25 miles per hour, was from 18½ to 25½ lbs. of coal per mile, or an average of 21 lbs. Experiments with an English engine showed a consumption of 12 lbs. per mile. The tests reported to the Master Mechanics' Association were, however, made with Western coal, which is not of so good a quality as English coal.

QUESTION 730. *How much coal do locomotives usually consume per train mile in ordinary service?*

Answer. This, too, varies within very wide limits. On the Lake Shore line, for example, the consumption for the year 1888 per train mile was 70 lbs. On the Pennsylvania road, in 1887, it was 91.2 lbs., whereas on the Philadelphia & Erie line, for the same period, it was 105.4 lbs.

QUESTION 731. *How much coal is consumed per car per mile?*

Answer. On the Pennsylvania Railroad, in 1887, the consumption of coal was 12.37 lbs. per passenger car per mile, and the average number of cars per train was 4.89. This was the total consumption of fuel by the locomotive which was apportioned to the cars alone, no coal being allowed for moving the engine and tender.

In the same year the consumption of coal per freight car per mile was 5.03 lbs. per car per mile, and the average train consisted of 24.16 cars. On the Philadelphia & Erie Division, which is a nearly level line, the coal consumed was only 3.18 lbs. per car per mile, and the average train consisted of 38.78 cars. The consumption of coal was divided among the cars alone, no allowance being made for the engine and tender. The monthly premium sheets of the Pennsylvania Railroad show that the consumption of coal, if apportioned to the cars alone, varies from 3.8 to 17 lbs. per freight car per mile, and from 9 to 24 lbs. for passenger cars. These figures give the *average* results on the roads named.

The following report of experiments, which were carefully made by the writer, will give the performance of a locomotive when great care is taken to produce good results. It should be stated, however, that the engine with which these experiments were made had been in service 18 months without receiving thorough repairs, and that the boiler at times primed badly, so that the rate of evaporation of water per pound of coal is not a fair indication of the performance of the engine in that respect. The coal used was known as Brazil coal, from Indiana, and in order to compare the performance of two engines only lumps of coal were used, so as to leave no room for question regarding the relative amount of fine coal used by each engine. The maximum grades on the road on which the experiments were made were 30 ft. per mile, and the total ascent from the lowest to the highest point on the road was 374 ft.

LOCOMOTIVE EXPERIMENTS.

	1873.	1873.	1873.
Date of experiment..........................	July 21.	July 28.	August 2.
Number of miles run..........................	145	145	145
Number of cars hauled..................	41	31	41
Total weight of cars, lbs..................	1,497,240	1,119,650	1,508,860
Total amount of coal burned, lbs..........	8,676	5,102	7,221
Total amount of water consumed, lbs	63 531	45.719	52,609
Water evaporated per lb. of coal, lbs.....	7.32	8.02	7.04
Miles run per ton (of 2,000 lbs.) of coal....	33.4	50.8	38.8
Coal consumed per car per mile, lbs......	1.45	1.13	1.21
Average speed, including stops, miles....	11.1	13	13.8

QUESTION 732. *How can we determine the speed at which an engine is running?*

Answer. In the absence of any special instruments for the purpose, BY COUNTING THE NUMBER OF REVOLUTIONS OF THE DRIVING-WHEELS PER MINUTE, THEN MULTIPLYING THE LENGTH OF THEIR CIRCUMFERENCE IN INCHES BY THE NUMBER OF THEIR REVOLUTIONS PER MINUTE AND THE PRODUCT BY 60, AND DIVIDING THE LAST PRODUCT BY 63,360. THE QUOTIENT WILL BE THE SPEED IN MILES PER HOUR. Thus, supposing driving-wheels which are 61½ in. in diameter, and whose circumference is therefore 193.2 in., should make 164 revolutions per minute, then $193.2 \times 164 \times 60 \div 63.360 = 30$ miles (nearly) per hour.

CHAPTER XXIX.

LUBRICATING CUPS.

QUESTION 733. *How are the journals of the axles of locomotives lubricated?*

Answer. The driving and engine truck axle boxes have oil-holes and receptacles on top, which are filled with cotton or woolen waste, into which the oil is poured when the engine is standing still. The tender axle boxes have receptacles below

Fig. 423.

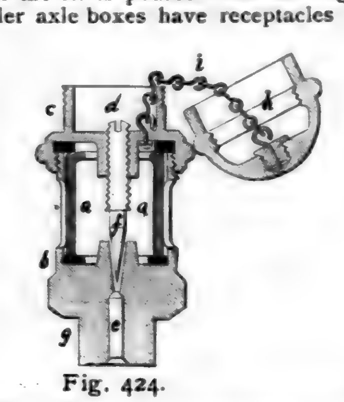


Fig. 424.

the journals, which are filled with waste and saturated with oil, as was explained in answer to Question 451.

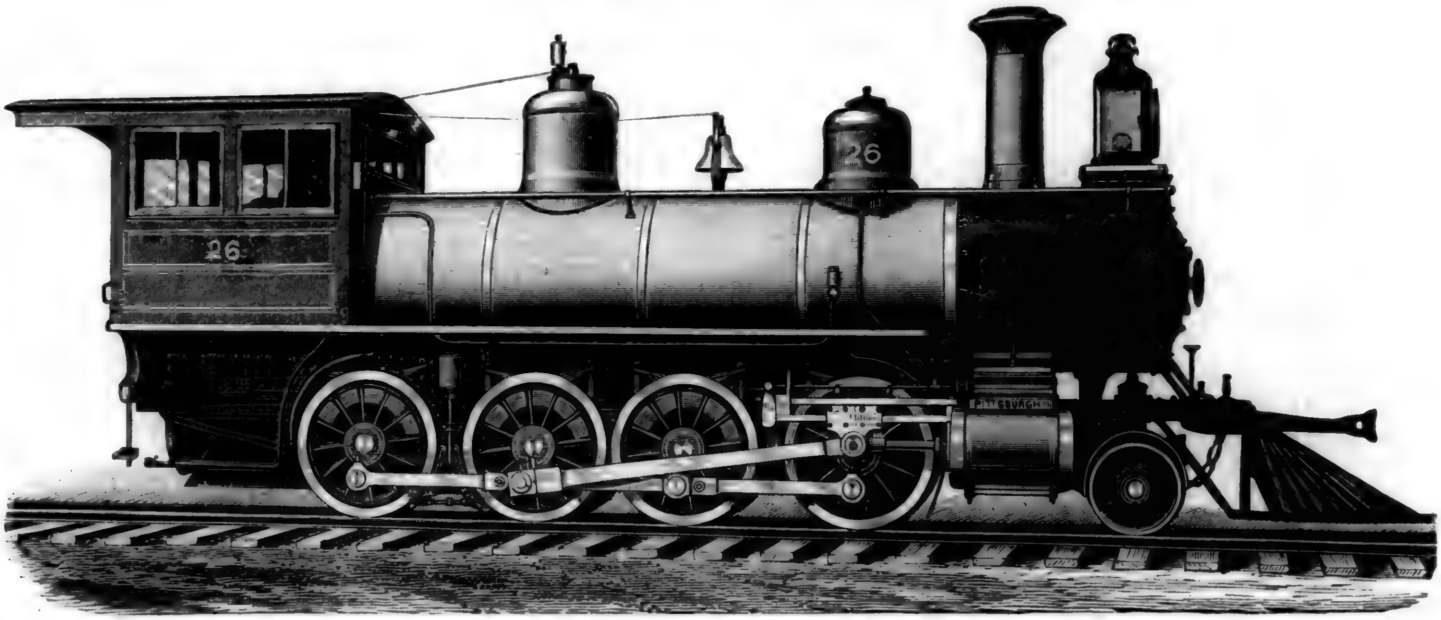
QUESTION 734. *How are the crank-pins and cross-head guides lubricated?*

Answer. The guides and the connecting-rods have oil or lubricating cups attached to them above the bearings. Such cups are shown in Plate III, on top of the guide-bars 62, and above the crank-pins 5 5. Fig. 423 is an outside and fig. 424 a sectional view of an oil-cup for locomotive guides.* It consists

* See report of that year, page 145.

* Manufactured by the Nathan Manufacturing Company of New York.

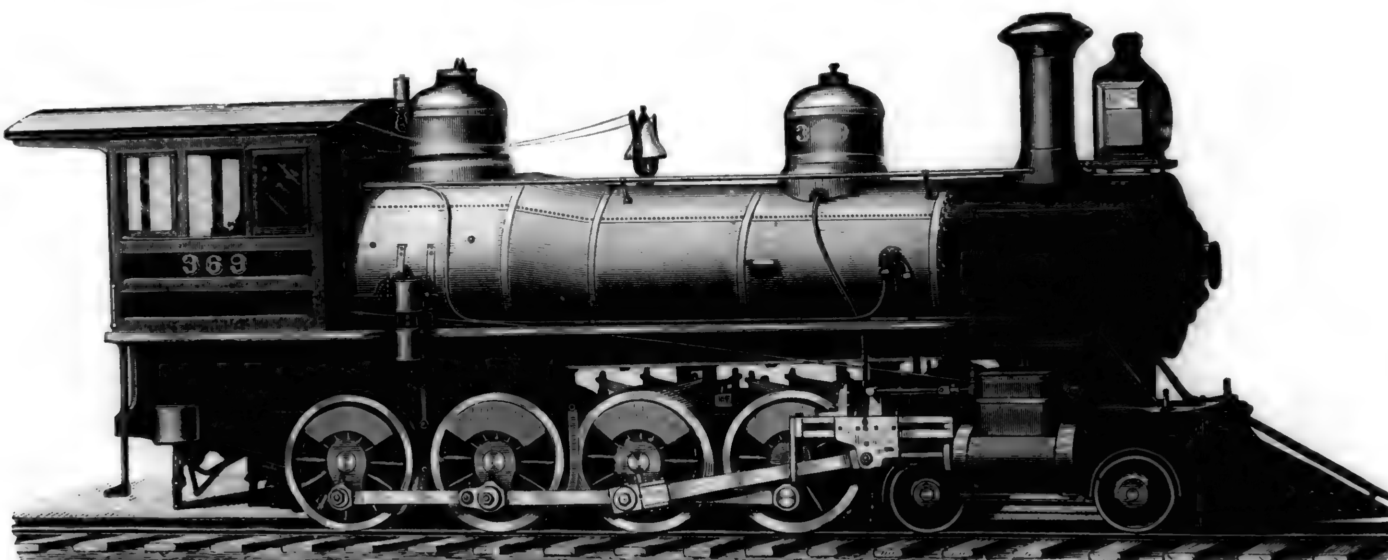
CATECHISM OF THE LOCOMOTIVE.



CONSOLIDATION LOCOMOTIVE.

BY THE PITTSBURGH LOCOMOTIVE WORKS, PITTSBURGH, PA.

Total weight in working order	104,900 lbs.	Outside diameter of smallest boiler ring	4 ft. 8 in.	Exhaust nozzles	Double.
Total weight on driving-wheels	94,150 "	Length of fire-box, inside	8 " 6 "	Size of steam-ports	16×1¼ in.
Diameter of driving-wheels	4 ft. 2 in.	Width of fire-box, inside	2 " 10⅜ "	Size of exhaust-ports	16×2½ "
Diameter of truck-wheels	2 " 6 "	Depth of fire-box, crown-sheet to top of grate	4 " 5⅜ "	Throw of eccentrics	5 "
Diameter of main driving-axle journal	7 "	Number of tubes	202	Greatest travel of valve	5 "
Length of main driving-axle journal	9 "	Outside diameter of tubes	2 in.	Outside lap of valve	0⅝ "
Distance from center of front to center of back driving-wheels	14 ft. 2 "	Length of tubes	13 ft. 2 "	Smallest inside diameter of chimney	1 ft. 6 "
Total wheel-base of engine	21 " 9 "	Grate surface	24.34 sq. ft.	Height, top of rail to top of chimney	14 " 5½ "
Total wheel-base of engine and tender	47 " 10½ "	Heating surface, fire-box	132.00 " "	Height, top of rail to center of boiler	6 " 9⅝ "
Diameter of cylinders	20 "	Heating surface, tubes	1,383.00 " "	Water capacity of tender tank	3,000 gals.
Stroke of cylinders	24 "	Heating surface, total	1,515.00 " "		



TWELVE-WHEEL LOCOMOTIVE.

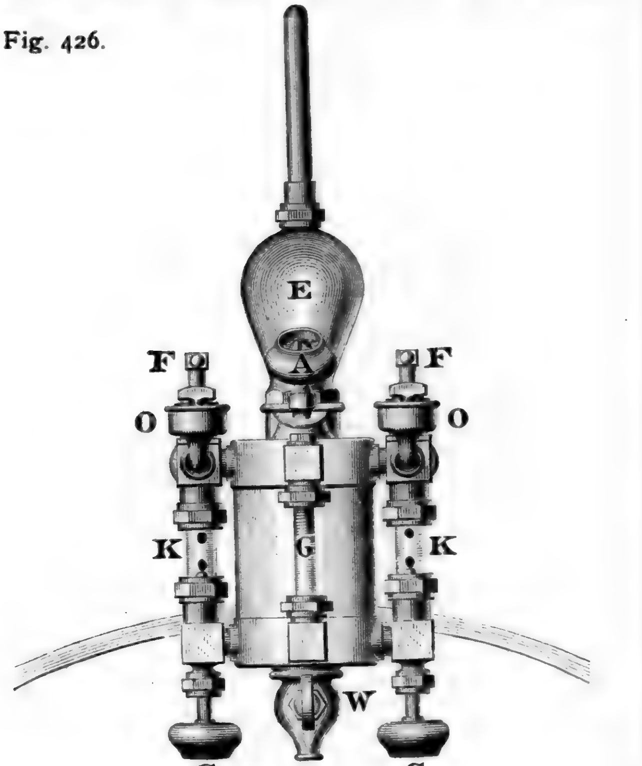
BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

Total weight in working order	132,000 lbs.	Outside diameter of smallest boiler ring	5 ft. 0 in.	Exhaust nozzles	Single.
Total weight on driving-wheels	112,000 "	Length of fire-box, inside	8 " 8⅜ "	Size of steam-ports	18×1¼ in.
Diameter of driving-wheels	4 ft. 3 in.	Width of fire-box, inside	3 " 6⅞ "	Size of exhaust-ports	18×2⅜ "
Diameter of truck-wheels	2 " 2 "	Depth of fire-box, crown-sheet to top of grate	4 " 11 "	Throw of eccentrics	5¼ "
Diameter of main driving-axle journal	7½ "	Number of tubes	262	Greatest travel of valve	5⅜ "
Length of main driving-axle journal	8½ "	Outside diameter of tubes	2 in.	Outside lap of valve	0¾ "
Distance from center of front to center of back driving-wheels	13 ft. 9 "	Length of tubes	12 ft. 8 "	Smallest inside diameter of chimney	1 ft. 4 "
Total wheel-base of engine	23 " 6 "	Grate surface	31 sq. ft.	Height, top of rail to top of chimney	14 " 10 "
Total wheel-base of engine and tender	47 " 10 "	Heating surface, fire-box	156 " "	Height, top of rail to center of boiler	7 " 6⅛ "
Diameter of cylinders	20 "	Heating surface, tubes	1,726 " "	Water capacity of tender tank	3,400 gals.
Stroke of cylinders	26 "	Heating surface, total	1,882 " "		

NOTE.—In this engine the first and third pairs of driving-wheels have blank tires, so that the *rigid* wheel-base is only 9 ft. 2 in.

of an internal glass-cup, *a a*, which is enclosed in a brass case, *b*, which has round openings on its four sides, so that it can be seen how much oil the cup contains. The glass cup is held in place by a cap, *c*, which is screwed on the case *b*. India-rubber washers are placed above and below the glass cup, to make tight joints when the cap is screwed down. The oil is poured

Fig. 426.



into the cavity *d* in the cap *c*, and runs down into the glass cup *a*, through openings not shown in the engraving. From *a* it flows to the bearings through the opening *e*. The rate of flow is regulated by a conical screw-plug, *f*, which can be adjusted so as to increase or diminish the flow of oil to the bearings. The lower part, *g*, of the cup is screwed into the guide-bars. The cap, *c*, has a loose cover, *h*, to exclude dirt from the cup. It is held by a chain, *i*, to prevent its being lost.

Fig. 425 is an external view of a similar oil-cup for connecting-rods. The cap is screwed on the case, and the flow of oil

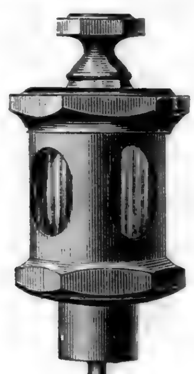


Fig. 425.

is adjusted by a small rod or pin, the lower end of which rests on the surface of the crank-pin.

There are a great variety of oil-cups in use, and much ingenuity has been exercised in devising appliances to regulate the supply of oil.

QUESTION 735. *How are the slide-valves and pistons of a locomotive lubricated?*

Answer. The method which was formerly employed was to attach an oil-cup to the top of the steam-chest, by which oil was supplied to the valve below when steam was shut off. To do this the fireman had to go to the front end of the engine. To avoid this pipes were connected to the steam-chests, and extended back to the cab with oil-cups in the cab, so that the valves could be oiled from the cab without going out to the front of the engine. Of late years what are called "*sight-feed lubricators*," which supply oil continuously to the cylinders, are used. These are placed in the cab, and are connected to the steam-chests by pipes. Fig. 426 represents an end view, fig. 427 a side view, and fig. 428 a sectional view on a plane parallel to that of fig. 426.* In lubricators of this class the weight of a column of water displaces the oil in the cup, and causes it to flow upward, drop by drop, through water in glass-tubes to the pipes, which are connected to the steam-chests.

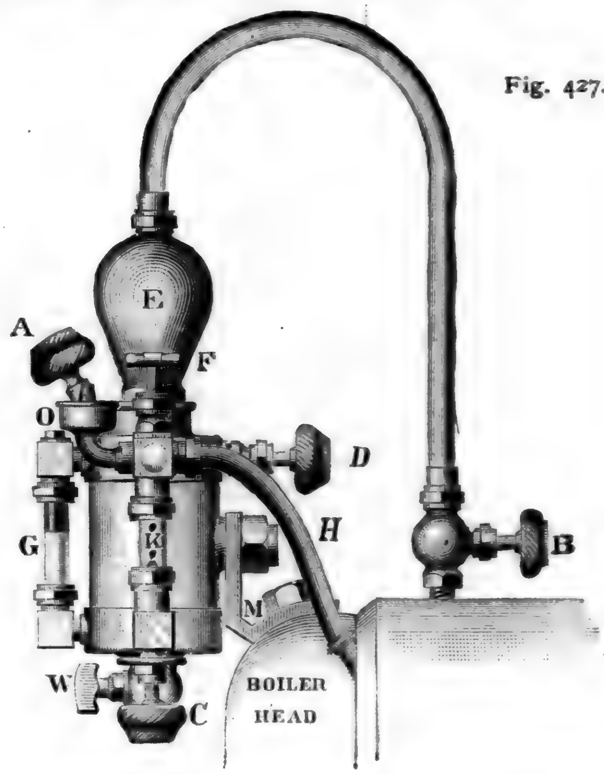


Fig. 427.

In fig. 428 *I* is the reservoir for holding the oil, which is filled through the plug *A*, fig. 427; *E* is a condenser, to which steam is conducted by a pipe on top connected to the boiler, as shown in fig. 427. As the steam is condensed in *E*, fig. 428, the water of condensation flows down into the reservoir *I* by a pipe not shown in the engraving, and the water being heavier than the oil, the

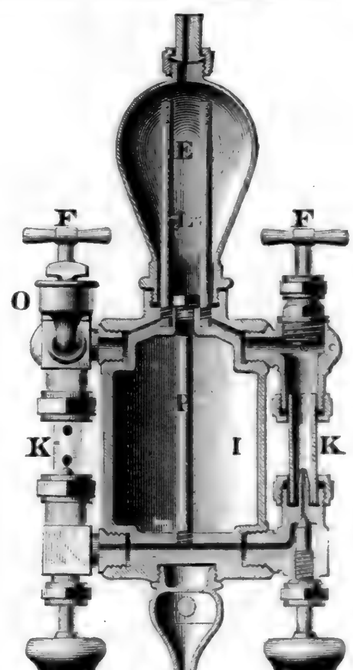


Fig. 428.

former sinks to the bottom of *I*, and the oil floats on top. If the reservoir is half full of water, and is then entirely filled with oil, the water as it condenses in *E* will flow down to the bottom of *I*, and cause the oil to flow slowly into the top of the pipe *P*, and from there down into the channel *J* below *I*, and thence to the glass tubes *K K*, which are filled with water by the con-

* Manufactured by the Nathan Manufacturing Company of 92 Liberty Street, New York.

densation of steam. This flows into them through the pipes *L*. The oil then passes upward, drop by drop, through the water in the tubes *K K*, as shown on the left-hand side of fig. 428, and it then passes by an opening above the tubes to the pipes *H*, one of which is shown in fig. 427, and through them to the steam-chests. The flow of oil is thus constantly in sight, and it can, therefore, be known whether the lubrication is continuous and regular. The pipes *L* inside of the reservoir conduct a small quantity of steam and water to the pipes *H*, after the glass tubes *K K* are filled, and in this way the oil, when it reaches the surface of the water in the tubes *K K*, mingles with the current of steam, which thus forms a steam lubricant that reaches and oils all parts of the valves and cylinders.

The quantity of oil entering the sight-feed glasses *K K* can be regulated by the valves *C C*.

The two sides of the lubricator form two distinct and entirely separate oilers, which work independently for each cylinder. The feed is regular and continuous, whether steaming or with steam shut off, going up or down grade.

Each side is provided with an independent "hand" or auxiliary oiler, *O*, to be used in case any of the glass tubes should break. The auxiliary oilers communicate directly with the pipes *H*, and can be used as simple oilers in case of need. In case one of the glass tubes should be broken, the valve *F* above it should be closed, which will prevent the escape of steam from the broken tube.

Another glass tube, *G*, forms a gauge to show the quantity of oil and water in the reservoir *I*, and a cock, *W*, is used to drain the reservoir *I* before refilling it.

The valve *D* opens or closes the opening which communicates from the condenser *E* to the reservoir *I*. This valve should be closed when the engine has completed its run. If it, the valves, *C C*, and the steam-valve, *B*, are left open, oil will continue to feed into the cylinders so long as there is any steam in the boiler.

(TO BE CONTINUED.)

Manufactures.

Blast Furnaces of the United States.

THE *American Manufacturer* gives its usual tables of the blast furnaces on May 1, and says: "A condensed statement of their condition is as follows:

Fuel.	In Blast. No.	In Blast. Weekly capacity.	Out of Blast. No.	Out of Blast. Weekly capacity.
Charcoal	60	11,951	104	11,170
Anthracite	103	35,078	88	22,574
Bituminous	139	91,239	87	37,803
Total	302	138,268	279	71,547

"This shows a reduction of 10 furnaces in blast as compared with one month ago. There are three less charcoal furnaces in blast, three more anthracite, and 10 less bituminous. The chief changes in the bituminous furnaces have been in Ohio. There is the same number in blast in the Mahoning Valley, one less in the Eastern, Central and Northern districts, two less in the Hocking Valley, three less in the Hanging Rock. In other districts the changes have been less, in some districts one going in and in others one going out.

"The appended table shows the number of furnaces in blast on May 1, 1889, and on May 1, 1888, with their weekly capacity:

Fuel.	May 1, 1889. No.	May 1, 1889. Weekly capacity.	May 1, 1888. No.	May 1, 1888. Weekly capacity.
Charcoal	60	11,951	60	11,956
Anthracite	103	35,078	104	30,366
Bituminous	138	91,239	133	80,230
Total	302	138,268	297	122,552

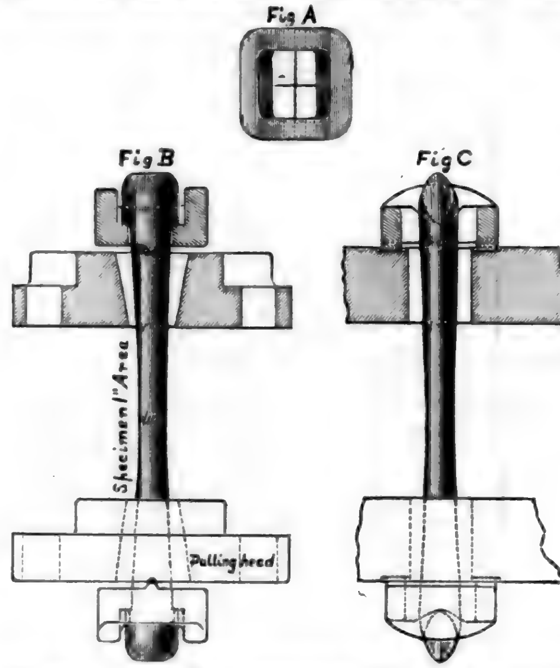
"It will be noticed that the number of furnaces in blast is about the same as one year ago, but the capacity, with the exception of the charcoal furnaces, is considerably greater."

Self-Adjustable Holder for Cast-Iron Specimens Under Test.

THE accompanying illustrations show a self-adjustable holder for cast-iron tensile test pieces, giving also the form of the specimen to be tested. Fig. *A* is a top view and fig. *B* a side view, showing the holder and specimen, while fig. *C* gives inside view of the holder, showing also the position and shape of the specimen under test.

To further explain the form of specimen and method of applying the test to so brittle a substance as cast iron, we would state that the specimen, as here shown, in one-eighth size, is round and reduced at the center or breaking point to 1.113 or 1 sq. in. area; from the center point the specimen gradually increases in size, and either end is formed with projecting lugs. These lugs

Fig A



rest on adjustable rocking bearings both above and below, and receive all the strain that is brought to bear upon the specimen. By this method the specimen naturally aligns itself, and the strain applied is received through the central axis and it is not possible for it to be subjected to any twisting or side strain. In view of the fact that cast iron is being subjected to tensile tests so much more than formerly, and of the difficulty that existed in arriving at a fair test without any side strain or even pull, the advantage of such an arrangement is obvious, and will be appreciated by all manufacturers of pig iron who are filling large contracts based upon physical tests, which are found to be as important as chemical tests. Many companies operating blast furnaces are providing themselves with patterns for making these tests, and almost daily, and as often as new ores and new mixutes are used for making iron, are having test specimens cast and forwarded to a physical laboratory of their own, or to the nearest testing laboratory operated by responsible parties. A transverse test can be made from a pattern 12 or 24 in. long, as may be preferred, and 1 in. square.

This holder is a new device made by the firm of Riehle Brothers of Philadelphia, for use in connection with their well-known testing machines.

Steering Vessels by Direct Power.

THE ordinary method of steering by hand from a tiller or a rope-drum with a hand-wheel is direct, the power being applied by the helmsman, and it is also reacting. The type of hand-steering gear in which the steering-wheel operates right and left screws and nuts is direct for the helmsman, but not reacting. The different kinds of steam-steering gear heretofore employed work with a worm-wheel and worms; they are not reacting, and can be disconnected at any position of the rudder only when provided with transmission through a friction cone arrangement, which is only used in light service.

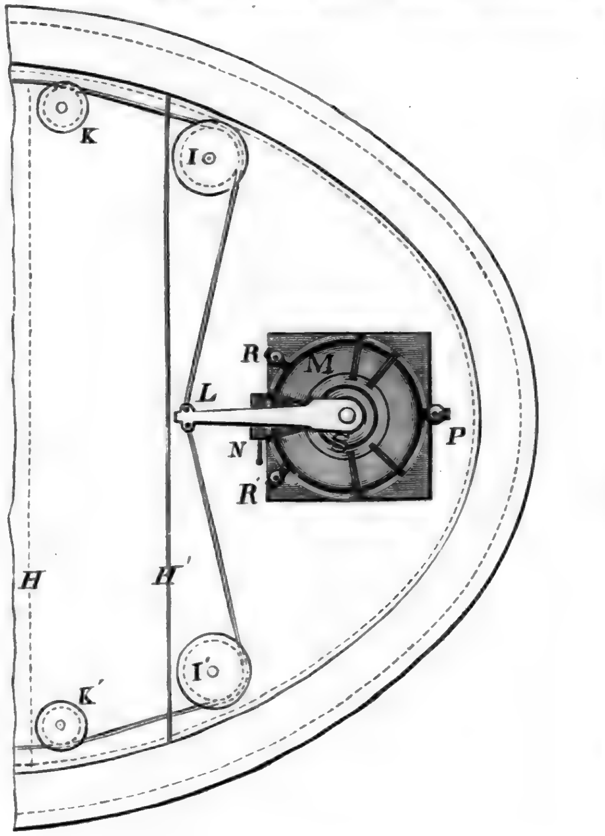
To connect a non-reacting steering gear with the rudder—usually by pins—requires the gear to be put in place exactly to meet the holes or sockets for the pins, usually at a central position, and this is difficult to accomplish, if one gear falls outside of that position. For this reason an arrangement in which only one gear is used at a time requires the withdrawal and change of pins at a central position for any change of operating.

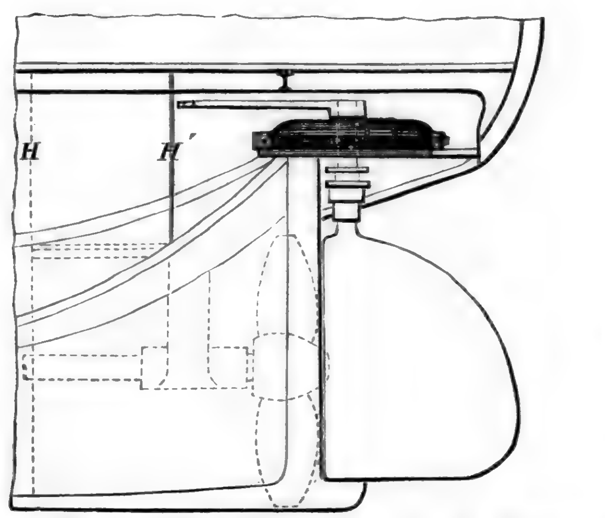
Full safety can only be secured when there are two steering gears in connection with the rudder, and when suitable provision is made, so that power may be applied without delay, without removing the pins and at any position of the rudder. Both gears must be reacting, or suited to be moved by and with each other.

A steam-engine for steering a vessel may be started and stopped with precision and perfection, but the momentum of a vessel tends always to keep it on the direct forward course, and the only method of preventing a collision in emergencies is by

a quick change of the rudder, which requires reliable and powerful machinery. The frequent damage of the rudder and destruction to the steering connections endangers navigation. It is often caused by the rigidity of the steering apparatus, as it is generally constructed, and by the impossibility of any reaction.

The accompanying illustrations show a new apparatus for

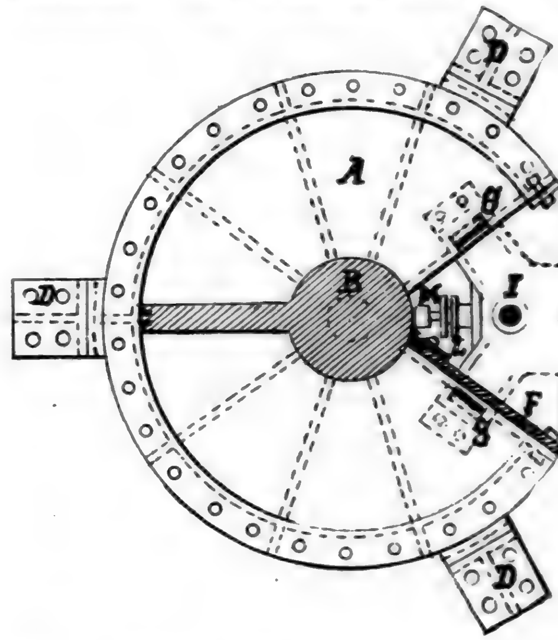


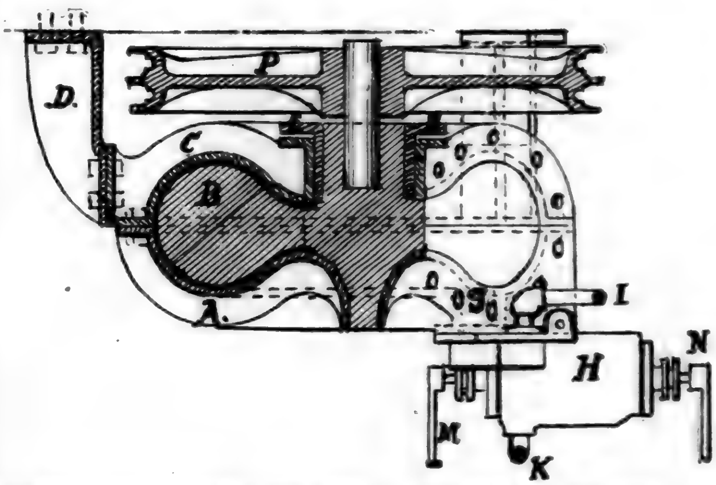


steering vessels by direct power. Fig. 1 and fig. 2 show the arrangement of this steering system in a vessel; *M* showing the motor; *N* the valve chest; *R R* the relief cocks; *P* the regulator cock, for the brake, and *S* the centering coupling. Figs. 3 and 4 are two views of the motor, or rather of one form of it, for several different forms can be employed to suit different cases.

This motor can be used either with steam or compressed air, and has the advantage that when necessary the change from power-steering to hand-steering and *vice versa* can be accomplished instantaneously. This is done by the employment of an additional valve which cuts off the supply of steam to the motor, and at the same time throws it open to the free circulation of the air, so that there is no obstruction to the motion of the piston in its case while the hand-steering apparatus is in use. It is not necessary when the motor is used to disconnect the tiller or other hand-steering arrangement, and the extra valve of the motor is operated by the relief-valve lever, which is placed close at the steering stand, so that the helmsman can make the change at once by a motion of his hand.

The construction will be readily understood from the illustrations given, and it is really very simple. The motor can be made with a single piston or with two or three pistons, as preferred, and can be proportioned to operate at a governed pressure. It can be connected directly to the rudder, or can work with a chain and gear, as may be most convenient. In many vessels, such as tugs and ferry-boats, a pulley motor can be placed under the deck at a convenient point below the pilot-house, and can be attached directly to the main steering ropes leading to the pilot-house. Steam can be used directly from the boiler,





and the motor and pipes can be well covered so as to avoid condensation as much as possible. If they are placed above the water line of the boiler they can be drained directly back to it, while the exhaust steam can be discharged into the water tank, and so utilized for heating the feeding water.

While in some cases compressed air may be preferred for the motor, it is probable that in a majority of instances the expense and space required would be less where steam taken directly from the boiler is used. In this case the connections are simplified, the cost of an air-compressor and reservoir is saved, and the space required for the air-compressor is also saved, which in small vessels may be an important consideration.

This apparatus is the invention of Mr. J. L. Hornig, M.E., and E. S. Wells, Jersey City, N. J., is agent and manufacturer.

Cars.

The United States Rolling Stock Company is building 23 passenger cars for the Alabama Midland road, at its shops in Hegewisch, Ill. At the same shops they are building 300 coal cars for the Central Railroad of Georgia and 150 ore cars for the Milwaukee & Northern. The Company's shops at Anniston, Ala., are building 200 box and 300 flat cars for the Georgia Southern & Florida.

The Jackson & Sharp Company, in Wilmington, Del., has

recently shipped passenger cars to the Richmond & Danville, the Alleghany Valley, and the Ulster & Delaware Railroad.

THE Decatur Car Wheel Company, at Decatur, Ala., has recently decided to double the size of its plant.

THE Michigan Car Company, in Detroit, has recently taken the contract to furnish 100 coal and 200 box cars to the Rome, Watertown & Ogdensburg Railroad.

Locomotives.

THE Schenectady Locomotive Works have taken an order to build three heavy passenger engines, seven yard engines, and 15 Mogul freight locomotives for the Lake Shore & Michigan Southern road.

THE Taunton Locomotive Manufacturing Company recently completed two 6-wheel switching engines for the Old Colony Railroad.

THE Mason Machine Company, in Taunton, Mass., recently completed a heavy locomotive for the Mexican Central Railroad of the double-truck pattern, designed by the late William Mason.

THE Canadian Pacific shops, in Montreal, have lately completed two passenger engines, with 20 by 22 in. cylinders, and driving wheels 6 ft. 3 in. in diameter. The boilers are intended to carry a working pressure of 180 lbs. These engines are to run the fast trains between Montreal and Toronto.

Bridges.

THE Hamilton Bridge & Tool Company, at Hamilton, Ont., is now at work on four iron bridges for the Grand Trunk and 21 for the Canadian Pacific Railroad.

THE San Francisco Bridge Company has bought the bridge-building business of Allen & Nelson at Seattle, Wash., and will enlarge the plant there, running it in connection with its works in San Francisco.

THE contract for the steel superstructure of two street bridges in St. Louis has been let to Stupp Brothers of that city. One of these bridges will cross the railroad track at West Jefferson Avenue and the other the river Des Peres.

THE contract for building 21 iron bridges on the Hartford & Connecticut Western Railroad has been let to the Berlin Iron Bridge Company. These structures are to replace old wooden bridges.

Iron and Steel.

THE Crown Point Furnace at Crown Point, N. Y., which was recently put in blast, is now running on Bessemer pig, using a mixture of Crown Point and Chateaugay ores.

AT the Homestead mill of Carnegie, Phipps & Company, near Pittsburgh, a number of 24-in. steel beams were recently turned out, to be used in building one of the new cruisers at Cramps' Ship-yard, in Philadelphia. These are the largest beams of the kind yet made here.

THE Scaife Foundry & Machine Company, in Pittsburgh, has completed a new Bessemer steel plant for Miller, Metcalf & Parkin of the same city. This plant will have all the latest improvements.

THE Emaus Pipe Works at Emaus, Pa., are filling a large order for 3-in. cast-iron water-pipe, to go to South America.

THE consolidation of the North Chicago Rolling Mill Company, the Union Steel Company, and the Joliet Steel Company has been completed, the capital stock of the new company having been placed at $25,000,000. The new company will own the extensive iron and steel works at North Chicago, Bay View, South Chicago, Calumet, and Joliet, besides the blast furnaces in Michigan and other outlying properties. It is stated that the South Chicago mills will be entirely devoted to the manufacture of steel rails, while the other works will be used for other products.

Manufacturing Notes.

THE Pond Engineering Company, of St. Louis, has recently opened a branch office at No. 51, Home Insurance Building, at Chicago. The Company now has offices in Chicago, Kansas City, and Omaha, in addition to the main office in St. Louis.

THE firm of Bradley & Company, Syracuse, N. Y., have recently purchased the business of Beaudry & Cunningham, of Boston, and will hereafter manufacture the Beaudry power hammer in addition to their own hammer.

THE Standard Metal Tie & Construction Company has removed its offices to No. 15 Cortlandt Street, New York.

THE office of Frank H. Andrews and of the Globe Iron & Spring Works has been removed to No. 556 West Thirty-fourth Street, New York City.

THE Cincinnati Corrugating Company is about to establish a sheet mill at Piqua, O., as an adjunct to its corrugating works in Cincinnati.

THE Armington & Sims Engine Company is building an addition to its Works, Providence, R. I. This addition will include a very complete room for testing and experimental purposes.

THE Curtis Regulator Company has recently furnished an 8-in. steam separator to the Tremont Nail Works, at West Wareham, Mass., being the third large separator furnished for those Works. The Company is also making a 10-in. separator for the Alexandria Bay & Thousand Islands Steamboat Company.

THE works of the Westinghouse Machine Company, in Pittsburgh, are fully employed in making the Westinghouse engine in its various sizes. These shops are equipped with machinery of the latest design, and with every possible improvement for facilitating the work, and many visitors are attracted to them on account of the completeness of their arrangements and the improvements which have been introduced. In addition to the home demand, the Company is now filling orders from almost every country in Europe, from Mexico, South America, Australia, India, and Japan. The Company is enabled to compete with foreign builders on their own ground, on account of the thoroughness of its system of manufacture and the excellence of its product, in spite of the higher wages paid in this country.

THE Standard Car Coupling Company, recently reorganized, now controls the patents of the Dowling Coupler, and it is manufacturing that device in a greatly improved form. The Company has its office at No. 45 Broadway, New York, and has established shops for the manufacture of the coupler at Troy, N. Y. The officers of the new Company are: President, E. C. Clark; Vice-President, William Jones; Treasurer, H. H. Burden; Secretary, A. P. Dennis.

THE Tobin bronze, invented by Passed Assistant Engineer John A. Tobin, U.S.N., and manufactured by the Ansonia Brass & Copper Company, is already in use in the Navy, and has been adopted on the Brooklyn Bridge, the Manhattan Elevated Railroad, and by a number of large manufacturing concerns. The advantages claimed for this bronze are great strength in resisting tensile and torsional strains, and marked anti-frictional and non-corrosive properties.

THE Dunham Manufacturing Company, Boston, has recently received orders for the Servis tie-plate, to equip 20 miles of the Maine Central road; also for the Chicago & Northwestern and several other roads. The Pennsylvania Railroad has placed an order for a number of these plates for trial. The Company now manufactures the Davies spike, which, it is claimed, is a marked advance, and in connection with the tie-plate has merits greater than those of any brace.

Marine Engineering.

THE Vogelsang screw propeller has recently received its first test on an ocean voyage. It was fitted on the Inman Line steamer *Ohio*, running between Liverpool and Philadelphia. On the first voyage out the ship made the passage in one day less than the average of a number of previous trips. Some results obtained are as follows: "The *Ohio* steamed up the Delaware from Cape Henlopen to Philadelphia, 100 miles, in 7 hours, against strong tide, with only 120 lbs. steam pressure, and an average of 59 revolutions. Highest steam pressure that can be carried is 150 lbs. With this the engines would run from 68 to 69 revolutions. Pitch of screw, 22 ft. 6 in. The highest speed attained with old screw, 71 revolutions, is 13.5 knots per hour. The highest speed attained with the Vogelsang screw is 15.2 knots, with 68 revolutions."

THE steamer *Puritan*, just completed for the Fall River Line, and which is expected to surpass in several respects her consort, the *Pilgrim*, went on her trial trip May 6 to test her engines. Only the builders of the engines, Messrs. W. & A. Fletcher, a representative of the Old Colony Steamboat Company, and a few personal friends were on board. The *Puritan* went about five miles outside of Sandy Hook, a distance of 25 miles, and returned to her pier, covering the 50 miles in about five hours, or an average of 10 miles per hour. The machinery worked well, but no attempt was made to test the speed. This vessel is the largest in the line, and her estimated cost is

$1,500,000. Her hull is of steel, built on the double-hull, bracket-plate, longitudinal system, with 96 water-tight compartments. In addition there are six water-tight bulkheads, dividing the hold into seven water-tight compartments. She is supposed to be practically unsinkable. She is 403 ft. long on the water-line, 420 ft. over all, or 30 ft. longer than the *Pilgrim*. Her hull is 52 ft. broad and 91 ft. over the guards. The depth of the hull is 21½ ft., and she draws 13 ft. of water when loaded. The interior of the steamer is finished in white and gold, and she has 350 state-rooms, or 100 more than the *Pilgrim*. It is estimated that she can carry 1,500 passengers comfortably. The boat is propelled by a compound beam engine, with high-pressure cylinder 75 in. diameter and 9 ft. stroke, and low-pressure cylinder 110 in. diameter and 14 ft. stroke. The working pressure is 110 lbs., and steam is furnished by eight boilers. The engines are expected to work up to 7,500 H. P.

Electric Notes.

THE Williams Engine Works are to have a Shaw electric traveling crane for their new shops at Beloit, Wis. It will have a span of 40 ft. and be proportioned for a working load of 15 tons, but is to sustain a test load 50 per cent. in excess of this, or 22½ tons, without injury. It is being built by Edward P. Allis & Company, of Milwaukee, who have had one of these cranes of 25 tons capacity in successful operation in their foundry for several months.

OBITUARY.

ROBERT W. WEIR, who died in New York, May 1, aged 86 years, was trained as an artist and appointed teacher of drawing in the United States Military Academy at West Point, in 1834, and in 1846 was made Professor. After 42 years of service at West Point he was retired in 1876 with the rank and pay of Colonel and has since lived quietly in New York.

WILLIAM J. TRACE, who died May 15, aged 24 years, was at one time with the *Railroad Gazette*, but for several years past had been connected with the *National Car and Locomotive Builder*. Mr. Trace was a young man of excellent ability and thorough integrity, and his early death, at a time when a prosperous and useful career seemed to be before him, will be regretted by many warmly attached friends.

MAJOR A. B. ROGERS, who died in Waterville, Minn., May 4, aged 59 years, had been for 33 years a resident of Minnesota. He was employed as an engineer on the Minnesota Central, the St. Paul & Pacific, and the Northern Pacific, but was best known by his very successful work in locating the Canadian Pacific through the Rocky Mountains, the line laid out by him through the Kicking Horse Pass having been finally adopted by the Company.

ELECTUS B. LITCHFIELD, who died in Brooklyn, N. Y., May 13, aged 72 years, was a prominent figure in railroad circles over 30 to 40 years ago. In connection with his brother, Edwin C. Litchfield, he held many heavy contracts; having built a large portion of the Terre Haute & Indiana, the Cleveland & Toledo, the Michigan Southern & Northern Indiana, and after their construction was active in the management of several of these roads. He also had several street railroad contracts, and was largely interested in the building of street railroads in Brooklyn, and the development of real estate there. For a number of years past Mr. Litchfield has been practically retired from business, doing nothing except to manage his property in Brooklyn.

WILLIAM H. BARNUM, who died at his residence in Lime Rock, Conn., April 30, aged 71 years, was born in Boston Corners, N. Y., and early in life entered into business with his father, who had established an iron foundry at Lime Rock. Mr. Barnum gradually extended his business until he owned all of the charcoal furnaces in Western Massachusetts and Connecticut, and controlled the output of the well-known Salisbury ore. He was the chief owner also of extensive car-wheel works at Lime Rock, and was engaged in many other similar enterprises.

Mr. Barnum was for a number of years prominent in politics, having served in the Connecticut Legislature, in the House of Representatives, and in the United States Senate. In this connection, however, he was best known as Chairman of the Democratic National Committee, a position which he held continuously from 1877 until his death. He was a prominent member of the American Iron & Steel Association.

GENERAL ADNA ANDERSON, one of the best known railroad engineers in the country, committed suicide May 14, while stopping temporarily at the Lafayette Hotel, in Philadelphia. He had been suffering for some time from brain trouble and it is believed that he was insane at the time of the suicide. General Anderson was born in 1827 at Ridgeway, N. Y., and after receiving an ordinary school education commenced work as a civil engineer on the first location of the New York & New Haven Railroad, in 1847. He served subsequently as Assistant or Resident Engineer on the Connecticut River, the Mobile & Ohio, and the Michigan Southern & Northern Indiana roads, and in 1855 became Chief Engineer of the old Tennessee & Alabama Road. He was afterwards Chief Engineer of the Edgefield & Kentucky and the Evansville, Henderson & Nashville. In 1862 he entered the Army, serving successively as Chief of the Construction Corps of the Army of the Potomac, Superintendent of Government Railroads in the Division of the Mississippi, and Chief Engineer and Superintendent of all the United States Military Railroads. After the war he was for a short time Chief Engineer of the St. Louis Bridge, then for four years General Superintendent of the Kansas Pacific, and for three years General Manager of the Wabash road. In 1875 he was appointed Receiver of the Chicago, Danville & Vincennes, and, when that road was reorganized, General Manager of the Paducah & Elizabethtown. In 1880 he was appointed to the important position of Chief Engineer of the Northern Pacific Railroad and held that office until 1886, when he was made Second Vice-President of the Company. He resigned that position about a year ago and had not since been very actively engaged in business, although he was President of the Auxiliary Fire Alarm Company. General Anderson achieved an excellent reputation as an engineer, having carried through successfully many important works, chief among which was the completion of the Northern Pacific. In spite of the many important positions which he held during his life he died a poor man.

PERSONALS.

J. M. MORRISON has been appointed Resident Engineer at Kansas City, Mo., of the Wabash Western Railroad.

W. M. CLEMENTS has resigned his position as General Manager of the Baltimore & Ohio Lines east of the Ohio River.

JAMES GAMBLE, C. E., of New York, has gone to Europe and will remain there during most of the summer, returning in the fall.

T. WILLIAM HARRIS & COMPANY of New York, have a contract for extending the gas works at Tarrytown, N. Y., to the neighboring village of Irvington.

CAPTAIN E. L. ZALINSKI, the inventor of the dynamite gun, has been appointed Military Attaché of the United States Legation, at St. Petersburg.

H. B. ABBOTT has been appointed Superintendent of Docks of the Lehigh Valley Railroad at Buffalo, N. Y., and will have charge of all transfers of traffic at that point.

HERBERT HACKNEY has resigned his position as Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad, and has started on a short trip to Europe.

W. I. MCCAMMON has been appointed Master Mechanic of the Mexican National Railroad, with headquarters in the City of Mexico, succeeding Mr. Winslow, who has resigned.

T. S. CHAPMAN has been appointed Superintendent of Motive Power of the Central Railroad of Georgia, with office in Savannah. He was formerly on the Chesapeake & Ohio.

J. T. ODELL has been appointed General Manager of the Baltimore & Ohio Railroad. Mr. Odell has had much experience in railroad management and has served on the Kansas Pacific, the Northern Pacific and other roads.

H. A. LITTLE has severed his connection with the Safety Car Heating & Lighting Company and is now with the Strong Locomotive Company of New York, which he will hereafter represent, with his usual ability, and, we trust, with his usual success.

W. W. PEABODY is appointed General Superintendent of the Baltimore & Ohio Lines west of the Ohio River and General Agent for the Company in Chicago. He has been for a long time connected with the Baltimore & Ohio System in different positions.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, May 1, a plane-table, made in 1656, and used by George Washington was exhibited. It is now the property of the Society. Mr. J. J. R. Croes presented a minute on Washington's work as a civil engineer. President Fteley read the Centennial address of the President which he had signed on behalf of the Society. It was announced that the Annual Convention at Seabright, N. J., would probably open June 20.

The paper of the evening was on the Fresh Water Algæ and their Relation to the Purity of Public Water Supplies, by George W. Rafter, Rochester, N. Y. Professor Albert X. Leeds, of the Stevens Institute, followed with some remarks on the same subject, and the discussion was continued to the next regular meeting.

The Tellers announced the following elections:

Members: Charles J. Bates, New York; Cornelius C. F. Bent, Joseph Ramsey, Jr., Cincinnati; Charles T. Church, Saratoga, N. Y.; Charles S. Churchill, Roanoke, Va.; Harry Frazier, Henderson, Ky.; George P. Hilton, Albany, N. Y.; Howard G. Kelly, Washington; George N. Merrill, Stanfordville, N. Y.; Andrew W. Munster, St. Paul, Minn.; James E. Willard, West Point, Ky.

Associate: William L. Abbott, Pittsburgh.

Juniors: John N. H. Cornell, New York; W. E. Crane, Alfred B. Allsworth, Pittsburgh; Oscar Erlandsen, Poughkeepsie, N. Y.; William L. Ferguson, Philadelphia.

The following circular has been issued to members by the Secretary, under date of May 9:

"The Convention will be held at Seabright, N. J., beginning on or about June 20, 1889. Seabright is on the Atlantic Coast, a few miles north of Long Branch, and within about an hour's time from New York by boat or rail.

"Arrangements as to transportation are in progress with the Passenger Associations and Committees, whereby it is expected that a rate of one and one third full fare will be made for the round trip from all points on the lines of the roads represented by such Association.

"You are invited to contribute papers or discussions on papers already published. A concise abstract of any paper to be presented should be sent to the Secretary not later than May 31. This will make discussion more probable, as a copy of the abstract will be sent to members who may be expected to contribute discussion.

"Please advise the Secretary if you will contribute a paper, or discussion on special subject."

At the regular meeting, May 15, the subject for discussion was Mr. Rafter's paper on Fresh Water Algæ and their Relation to the Purity of Public Water Supply, which was continued over from the previous meeting.

American Society of Mechanical Engineers.—The spring meeting of this Society was held in Erie, Pa., beginning May 14, when the usual addresses of welcome were made and an address delivered by ex-President Horace See, the meeting being followed by a social reunion.

On May 15 there was a business session at which the reports of the officers and Council were presented and a number of papers read; and in the afternoon the members visited the Erie City Iron Works and other manufacturing establishments. In the evening a second session was held for the reading of papers and topical discussions.

On Thursday morning a session for reading papers and topical discussions was again held. In the afternoon more visits were made to manufacturing establishments, including the Ball Engine Company, the Watson Paper Mill, and others. The evening was devoted to a reception tendered by resident members and friends to the visiting members and their ladies.

On Friday the meeting ended with a cession for reading papers and discussion and a short business session for transacting the usual routine business. After this the meeting concluded with a sail upon Lake Erie and a visit to the Erie Water-Works, closing pleasantly a very successful meeting.

United States Naval Institute.—An interesting and instructive paper was read before the Naval Institute, at Annapolis, May 17, by Mr. S. D. Greene, a former officer of the Navy, entitled Electricity on Board War Ships.

The object of the paper was to bring to the notice of naval officers the extent to which electricity is being used for the transmission of power for commercial purposes.

One of the latest electrical devices described by Mr. Greene was the new range-finder, invented by Lieutenant Fiske. Its accuracy, as proved by elaborate tests, is something remarkable, and its general usefulness on board ship for taking bearings, distances, angles, etc., will be readily appreciated by all interested in the nautical profession.

The Engineers' Club.—The new house of this Club, No. 10 West Twenty-ninth Street, New York, was opened by a reception on April 27. The Club has now 350 members, and the Treasurer reports a balance in the treasury of about $14,000.

Engineers' Club of Philadelphia.—At the regular meeting of April 20, the Secretary presented a letter from Mr. Samuel T. Wagner on Standard Rivet Symbols.

The Secretary presented, for Mr. H. A. Vevin, tracings and description of six Gallows Frames, erected at mines near Leadville, Col.

Professor H. W. Spangler described an instrument for Summing up the Lengths of Lines, consisting of a pair of dividers with a registering device attached. He explained its use in determining the area of indicator cards, by dividing the card into vertical trapezoids of equal width, obtaining the aggregate of the average height of each with these dividers, and multiplying by the width.

At the regular meeting, May 4, the tellers announced that all the votes cast upon the proposed amendments to the Constitution failed to pass.

Mr. J. E. Codman presented a table of dimensions of Pipe Flanges and Cast-Iron Pipes for the *Reference Book.*

A paper on Color, by Mr. Robert A. Cummings, was presented by the Secretary.

Mr. Arthur Marichal called the attention of the Club to a paper read before the Society of Civil Engineers of Paris by M. Decordemoy, in which he describes the Recent Improvements of the Harbor of Bilbao, Spain. This was discussed by Professor L. M. Haupt and others present.

Professor Lino F. Rondinella explained two Diagram Tables, one of which gives graphically the relations of lines and areas in polygons, and the other the relation between English and metric measurements.

Western Society of Engineers.—At the regular April meeting in Chicago, John S. Glenn was chosen a member. The Committee on Permanent Quarters made a report announcing that they had leased rooms, which was received. After a long discussion on the financial condition of the Society, it was resolved to increase the annual dues to $10. A committee was appointed to propose amendments to the constitution and by-laws.

Resolutions were passed congratulating Mr. D. C. Cregier, a member and former President of the Society, on his election as Mayor of Chicago.

Engineers' Club of St. Louis.—At the regular meeting, April 17, the Chairman announced the death of Colonel Henry C. Moore, one of the oldest members and a former President of the Club. He also announced that President Meier had volunteered to prepare a memoir, which he expected to be able to present at the next regular meeting.

Professor Charles C. Brown's paper on the Sanitary Condition of the Water-Supply of New York City was then read by Professor Wheeler. Professor Brown, being Engineer of the New York State Board of Health, had devoted considerable time and study to the subject.

Messrs. Holman, Bryan, Wheeler, Thacher, Ferguson, and Bouton took part in the discussion.

The Secretary then read a paper by Mr. A. J. Frith, describing a system of marking patterns. The question was treated in detail, and the desirable points explained. A sample record sheet was submitted. Mr. Frith also submitted a brief discussion of economy of manufacture as viewed in the pattern.

Mr. Crow described a system of marking small patents, which had been in use very successfully.

At the regular meeting, May 1, C. H. Howard and Pope Yeatman were chosen members. A resolution was passed providing for a standing committee to prepare for publication a book containing information with regard to the materials for engineering in use in St. Louis and vicinity, another memorandum of a local nature, useful to engineers.

Professor H. B. Gale then read a paper on a new theory of Chimney Draft and the design of Brick and Iron Stacks. The author had made numerous experiments to determine the different factors which entered into the problem, and gave some formulæ in shape for convenient use. The difference between brick and iron stacks was discussed. He showed that while the

area of a stack could not be reduced below certain limits, it could be increased without affecting the efficiency of the stack. Professor Johnson, Mr. Holman, Mr. Laird, Nils Johnson, and Mr. Bryan took part in the discussion.

AT the regular meeting, May 15, T. J. Long and O. H. Schramm were elected members. President Meier read a memoir of the late Colonel Henry C. Moore, ex-President of the Club.

Mr. J. A. Seddon read a paper describing experiments he had made concerning the Settling of the Water in the settling basins of the St. Louis Water-Works. The discussion of this paper was made special order for the next meeting.

Professor J. B. Johnson presented a paper on Trussing a Large Building in St. Louis against Wind Pressure, which was discussed by Messrs. Holman, Moore, and Flad.

Professor F. E. Nipher made a valuable report on a recent investigation into the performance of an engine working at a fixed cut-off without governor. Measuring the brake horsepower, the pressure of the supply steam and the speed, he finds that the performance of the engine is represented by a hyperbolic paraboloid, in which the lines of constant load and the lines of constant speed are rectilinear elements. At any fixed pressure the relation between output and speed is represented by a parabola, the vertex of which represents a condition of maximum output. This was discussed by Messrs. Holman, Gale, and Flad.

Engineers' Club of Kansas City.—At the regular meeting in Kansas City, May 6, Robert A. Crawford was elected an associate member.

The Committee on the Transfer of Members presented a final report. It was thought that the decision on any scheme should rest with the Board of Managers of the Association; that local societies of acknowledged standing should be invited to cooperate; and it was recommended that our Representative be requested to lay the matter before the Board.

It was voted that a copy of the report be laid before the Board of Managers of the Association of Engineering Societies.

A standing Committee on Cements and Mortars was appointed, consisting of Messrs. D. Bontecou, W. D. Jenkins, and E. Saxton. A special committee was also appointed to make arrangements for the annual summer excursion.

A paper on the Foundations for the Limfjord Bridge was read by Mr. O. F. Sonne. The bridge was built in 1874–78 across the Liimfjord, near Aalborg, for the Danish State Railways; it has four spans of 206–226 ft. and two draw spans of 88 ft. each. The piers were sunk by the pneumatic process through soft and tenacious mud, one of them to 59 ft., the six others to 111.55–113.50 ft.; they were built with iron caissons, the masonry of hard-burned brick laid in Portland cement, the upper part protected by granite; they were lowered from scaffolds and kept suspended, during the sinking, each by four rods or chains hooked around the cutting edge. Through a combination of circumstances one of the piers was overturned and it located on the center-line of the bridge; a new pier was lowered and had to be carried through the old one. The work was done under contract by a French firm, the Compagnie de Fives-Lille.

Denver Society of Civil Engineers & Architects.—At the regular meeting in Denver, Col., May 7, the greater part of the meeting was devoted to the discussion and adoption of a new Constitution and By-Laws. The Society desired to discuss these matters thoroughly, in order to avoid some of the pit-falls into which other technical associations have fallen. The Constitution contains some changes from most of those of similar Societies. For instance, nominations for officers are made in open meeting a month before the election; as many candidates are named for each office as members wish, and these nominations may be also by letter.

Major J. W. Powell, Director of the United States Geological Survey, was elected an honorary member.

The officers of the Society are: President, E. S. Nettleton; Vice-President, R. A. Wilson; Secretary and Treasurer, W. W. Follett; Executive Committee, the President, the Secretary, Professor P. H. Van Diest, F. E. Edbrooke, and R. D. Hobart.

New York Railroad Club.—A special business meeting was held in New York, May 6, at which it was resolved unanimously to hold the annual banquet at Delmonico's in New York, on the evening of May 23. A committee of arrangements was appointed and it was expected that the dinner would be a notable one; prominent railroad men were expected to be present and to make addresses.

Western Railway Club.—At the regular meeting in Chicago, May 21, the subject for discussion was the Rules of Interchange, with a view to suggesting amendments to those rules to be made at the coming convention of the Master Car-Builders' Association.

New England Railroad Club.—The regular meeting in Boston, May 8, was devoted to the discussion of the Master Car-Builders' Rules for the Interchange of Cars. Messrs. Adams, Marden, Lauder, Fletcher, and others took part in the discussion, in which a number of points were brought up, and amendments were suggested to be presented at the Convention.

Master Mechanics' Association.—A circular of inquiry has been issued by the Committee on Driver Brakes, requesting information on the use of such brakes of various patents. The Chairman of this Committee is Mr. Charles Blackwell, Savannah, Ga.

The Committee on Boiler Covering also issued a circular requesting experience and opinions on the Best Method and Material for Covering Locomotive Boilers. The Chairman of this Committee is Mr. G. W. Stevens, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railroad, of Cleveland, O.

Another committee circular asks for information as to the Best Proportion of Flue and Grate Area in Locomotives, for burning bituminous coal. Answers to this circular are to be sent to J. Davis Barnett, Grand Trunk Railway, Stratford, Ont.

Master Car-Builders' Association.—President William McWood has issued the following circular to members:

"I regret to inform you of the resignation of Mr. M. N. Forney from the position of Secretary of the Master Car-Builders' Association. Considering Mr. Forney's long connection with the Association, and the valuable services rendered by him for some years as Secretary, you will with me feel the loss the Association sustains in his resigning so important a position, and I am sure that I only echo the sentiments of the Executive Committee in suggesting resolutions expressing the appreciation of the Association for Mr. Forney's very satisfactory services, to be presented at the next Convention by the Executive Committee.

"In connection with the Secretaryship, I am pleased to inform you Mr. John Cloud has accepted the position, and from his well-known ability I am sure you will agree with me that the Association has been fortunate in securing his services.

"Mr. Cloud's address is Buffalo, N. Y."

AT the meeting of the Arbitration Committee, held in Chicago April 24, the following action was taken:

"Rule No. 30 of the Code of Rules of the Master Car-Builders' Association requires the Arbitration Committee to ask from its members by circular suggestions of changes, amendments and additions to these rules, who shall revise and formulate such replies as they may receive, for presentation to the Association at the next regular meeting.

"In accordance with the above rule, it was resolved that the Committee respectfully requests the railroad clubs to offer such suggestions relative to amendments as they may see proper to make.

"The Committee will be glad to receive suggestions also from any individual member of the Association.

"As the time of the meeting of the Association is very close at hand, prompt attention to this matter is respectfully requested."

Communications should be sent to F. D. Casanave, Chairman, Fort Wayne, Ind.

NOTES AND NEWS.

Rapid Electric Transit.—Mr. John T. Williams has recently exhibited in Boston what he calls the "Portelectric System" of transportation for letters and small packages. The model shown consisted of a track some 50 ft. long, with an up-grade of 6 in. to 100 ft. upon wooden posts about 3 ft. high. On this track was the car, which is about 4 ft. long, and weighs, in this particular instance, 56½ lbs. Around the track, in vertical planes at right angles to its length, were coils of wire every two feet. They were covered so that the wire was not visible, and formed, as it were, a series of rings through which the car passed. The car ran on a single track, had a wheel at each end, and was kept in position by a guide rail over the top. The track itself formed one part of the electric circuit, and the wire in the coils, which were all connected, formed the other. The car itself was a great magnet. Power was obtained by sending a current of electricity through the circuit. This was the whole apparatus.

The bottom fact in it is what has been known for many years,

that an insulated coil of wire has an attractive force or suction for a magnet, and that it will draw a magnet of not too great size directly within it till it is exactly at the center. It is this knowledge applied which is the essential thing in the "Portelectric System." The first coil of wire is made stronger than the others, in order to start the car from its position of absolute inertia. The apparatus is so made that the suction of the coil draws the car within it, but just before it reaches the center, by automatic action the current is cut off and the motion of the car continues. Then it is within the attractive force of the second coil. This is made in the same way. The retarding action of the coil is again cut off, and only the drawing power is permitted to work. As the car is 4 ft. long, and as the coils are only 2 ft. apart, it will be seen that the front end of the car is within the influence of the next coil, while the middle of the car is directly at the center of the coil it has last reached. So the car is constantly subject to the onward motion.

The inventor claims that the car may be made to hold, say 10,000 letters, and can be run from Boston to New York in two hours. Stations could be established along the route for furnishing the electrical force which might be needed. Mr. Williams said in his explanation that probably five stations would be needed between Boston and New York. Mails could be easily transported with great speed and at small cost. Only as much power as was needed would be used, for the invention would automatically return to the station all of the power which was not needed. The expense of the system could be reduced by having the coils further apart. Perhaps they need not be nearer to each other than 20 ft. The length of the car might be increased to 10 or 12 ft. The size of the apparatus might be increased with an increase of its speed and efficiency. Instead of being limited to the carrying of mail matter and packages, he thought that the apparatus might be enlarged so as to carry a person and very probably several persons at once.

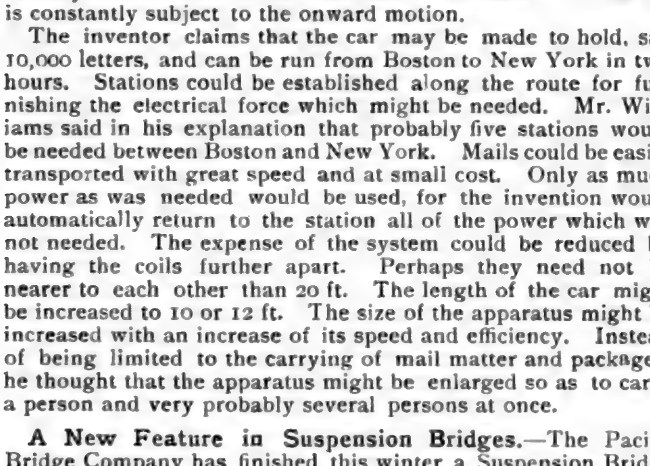
A New Feature in Suspension Bridges.—The Pacific Bridge Company has finished this winter a Suspension Bridge at Oregon City, Or., of 820 ft. length, with a span of 466 ft. between towers.

The clear height for navigation is 75 ft., and the towers are 90 and 100 ft. high respectively.

Special care had to be taken in designing and constructing the bridge, as the floor for the whole bridge is on a grade of 1 in. in 20 ft.

As usual with such kind of work, a great deal of it had to be done from carriages supported from the cables.

A novel feature, and one that is said to be entirely new, is



the introduction of self-adjusting or counter-balanced reversed cables, to materially add to the stiffness of the bridge.

The extreme ends of the cables, instead of being anchored in definite position, are attached to concrete blocks as shown in sketch—which weigh about 10,000 lbs. each, running over wheels *b*. The wheels are supported by iron beams *c*, resting on the walls of a shaft *d*. The concrete blocks or counterweights, being able to move up and down, keep the cables always under a constant strain to the amount of the weight of the block, which overcomes all vibrations caused by teams, and prevents crystallization of the cables.

If, however, a heavy wind should produce a strain in the reversed cables greater than 10,000 lbs., such an additional strain is transferred or taken up by the special anchors *e*, which are carried back and anchored in the rock.—*Pacific Lumberman and Contractor.*

The Brooklyn Bridge.—At a meeting of the trustees held May 13, it was decided to increase the terminal facilities by enlarging the stations, widening the platforms and stairways, and laying additional tracks, the total estimated cost of the improvements to be $409,000, of which $259,000 will be required for the property taker.

In the three days covered by the Centennial celebration in New York, 588,111 people crossed the bridge, of whom 453,329 were carried in the cars.

Detroit River Bridge.—The Commission of engineer officers, appointed by the Secretary of War, has held several sessions in Detroit, to consider whether the construction of a bridge is practicable. Mr. Gustave Lindenthal announced that he would submit plans for a bridge to consist of two stone piers connected by a central span 1,095 ft. in length. The spans leading from the piers to either shore are to be 787 ft. long. The main roadway of the bridge is to be 135 ft. above the water, permitting the tallest masts to pass underneath. The towers are to be 295 ft. above the level of the water, and 100 ft. below, extending down to the rock foundation. The approaches to the bridge are to be over a mile long. It was estimated that the total cost would be $6,500,000.

There is also a proposition to build a low bridge for winter use, whose central spans could be removed in summer; and tunnels are also talked of.

A Great Dry-Dock.—The new dry-dock at Newport News, Va., built by J. E. Simpson & Co., of New York, for C. P. Huntington and associates, under the supervision of Francis Collingwood, C. E., was formally opened on April 24, by docking the monitor *Puritan* with suitable ceremonies, which were concluded by a banquet.

The Simpson Company is building docks in Norfolk and Brooklyn, and will soon begin a dock at Philadelphia for the Government. C. B. Orcutt is the President of the Chesapeake Dry Dock & Construction Company at Newport News. The Southwark Foundry & Machine Company, of Philadelphia, built all the pumps and machinery for the dock, which can receive vessels with cargoes on board and drawing 25 ft. of water.

The dock is 600 ft. long from coping at head of dock to outer sill; 130 ft. wide at top and 50 ft. at the bottom, and 33 ft. deep, with a slope in the bottom of 24 in. to the 560 ft. The approach to the dock is 150 ft. wide, between two pile piers—one 80 ft. wide and 250 ft. long on the south, and one 60 ft. by 250 ft. on the north. The caisson is an iron structure, 96 ft. long on top, 50 ft. at bottom, and 33 ft. deep, and with an extreme width of 20 ft., and has eight culverts, 22 in. in diameter, for filling the dock, and two, 18 in. in diameter, for use in sinking the caisson. It is provided with steam power for pumping out the water ballast, a 6-in. centrifugal pump and a steam capstan.

The dock is supplied with two 40-in. centrifugal pumps of a capacity of 44,000 gallons per minute, the two together emptying the dock in 1 hour, 37 minutes, the contents being about 8,500,000 gallons. These pumps have disks 5 ft. 6 in. in diameter, suction pipes 42 in. in diameter, and ejection pipes 40 in. The pumps are admirably designed. The main engines are vertical, and attached directly to the pumps. They have 24 × 24-in. cylinders, phosphor-bronze bearings, and a variable cut-off, working readily up to 145 revolutions per minute. Their combined power is 500 H. P.

There is also a 12-in. centrifugal drainage pump with separate boiler. The main boilers are 13 ft. in diameter and 11 ft. long, with three internally fired furnaces, each 3 ft. in diameter, with 90 tubes 3½ in. in diameter.

The dock is as "tight as a bottle." One of its great advantages is the small rise and fall of tide, which is but 2 ft. 8 in., so that at low tide 22 ft. 4 in. can be carried over the inner sill, thus allowing a vessel to be docked at all stages of tide. The shipyard adjoining will give every facility for making repairs of all kinds and for ship building, and the location so near the stormy Cape of Hatteras should bring an abundance of business.

An Alloy of Steel and Copper.—Schneider & Company of Creusot, France, have taken a patent for a process, which consists in making, either in crucible or by open-hearth process, steel alloyed with a variable proportion of copper. The patent covers also the application of this metal to the manufacture of guns, armor plates, projectiles, and other war material; also the plates, bars, etc.

To make this copper-steel they use ordinary copper or a cast copper, taking care to avoid the oxidation of the copper before it unites with the steel. With this object the copper is introduced either at the beginning of the melting in the interior of the steel, both which is covered by a layer of slag, or near the end of the heat at the moment when the carbonizing elements are added. In this way they obtain steel alloyed with from 2 to 4 per cent. of copper, which has, it is claimed, remarkable qualities of elasticity, resistance, and malleability.—*Revue Scientifique.*

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THE Chesapeake & Ohio Canal was very badly damaged in the recent freshets, and there seems to be some doubt as to whether it will be possible to secure the necessary capital to repair or rebuild it. The canal runs from Georgetown to Cumberland, and the State of Maryland is the principal stockholder. Its chief traffic is in coal from the Cumberland region, and while it carries very much less of that coal than the railroads do, it has been of considerable importance as a regulator of rates.

THE Governor of the State of New York has approved the bill providing for the organization of a Naval Reserve, which is to consist of three battalions, to be divided between the seaboard and the lakes. They are to be part of the National Guard of the State, and to be governed by the same laws. The Naval Battalions will be composed of persons engaged in seafaring pursuits, and will be drilled in accordance with naval rules. They are to have also a period of sea training each year, provided the United States will furnish the proper vessels. The law is very similar to that proposed to Massachusetts and one or two other States.

THE Cincinnati Association of the Society of Civil Engineers has prepared for submission amendments to the Constitution of the American Society, bringing up again what has been proposed several times before this, the division of the Society into districts, arranged geographically, and an adjustment of the representation in the Board of Directors by districts. The reasons for this are stated in a pamphlet which has been issued by the Society and generally distributed.

THE connections of the Poughkeepsie Bridge are finally completed, as far as laying track is concerned, and trains will begin to run over the bridge early in July. The Western connection is an extension of the Lehigh & Hudson River Railroad, and through that road connects with the Erie, the Lehigh Valley, and the Pennsylvania Railroads. The Eastern line extends from Poughkeepsie to a connection with the Hartford & Connecticut Western road, which will be the main outlet eastward for traffic passing over the bridge, at least until a further connection is made with the New York & New England.

SUBMARINE torpedo-boats are now engaging a good deal of attention among naval men, both in this country and in Europe. Some French experiments have been made with a boat, which is described as being spindle-shape, 6 ft. in diameter by 56 ft. in length; provided with torpedo-tubes and driven by electricity, the power being furnished by storage batteries, while the submersion of the boat is regulated by means of water tanks. There is some mystery surrounding the result of these experiments, but it is reported that the boat has been very successful. French officers are also experimenting with a smaller boat of a similar shape, but 15 ft. long only and carrying but two men. The service this small boat is to do is as a detector of submarine torpedoes and mines, and a destroyer of the wires and cables which serve as their sure connections.

An appropriation has been made for the construction of a submarine boat for our own Navy, and the Navy Department has now under consideration bids received for the same. The one which will most probably be accepted is from the Columbian Iron Works, of Baltimore, for a vessel having 12 knots surface speed and 9 knots submerged speed, the general design of which is similar to what is known as the Holland boat; the motive power of this vessel will be steam generated by burning petroleum, while the boat is running on the surface and stored up in the boilers when she is submerged. She is to be submerged automatically by means of rudders on either side, which are to be so arranged as to plunge her beneath the water. Even when running on the surface, she will be invisible at a comparatively short distance, and should be able to use her dynamite gun very effectively at close range.

THE Atchison, Topeka & Santa Fé is a striking example of the condition into which over-building, over-confidence, the rage for acquiring new "territory," and the resulting excessive competition have brought the railroads of the Southwest. Only a short time ago the Atchison was one of the soundest of the new railroad properties, with a well-placed system of roads, commanding a large traffic and not only earning its fixed charges, but paying 6 per cent. dividends—actually earned—on its stock. The entrance of other lines into its field was to be expected, and the effort to meet them by covering the territory with branches was perhaps not unnatural; but it has resulted, as all such contests do result, in disaster, the company which expanded most recklessly being the first to fail.

Building branches and extensions in advance of settlements to develop new country is justifiable in many cases, and the result may be good if a railroad can keep the business to itself; but building competing lines to fight for business which does not yet exist is a dangerous experiment, as the railroads found out in the Northwest some time ago. In the Southwest it has been tried over again with results which threaten to be more disastrous, because the process has been carried further, and in a country in which growth is slower and is also of a variable and intermittent kind, and which has fewer natural resources. In Wisconsin, Iowa, Minnesota, Nebraska, and Dakota there has been sharp competition among the railroads, with consequent reduction of rates to a point at which the margin of profit

is very small; but this has been partly made up by a steady increase in business, since in that region settlement is of a more stable character, the crops are more regular, and the bulk of traffic to be carried much greater than is ever likely to be the case in a dry region like Western Kansas, or a grazing and pastoral country like New Mexico and Southern Colorado and Texas; while a mining region like Central Colorado or Arizona is notoriously unreliable as a source of traffic.

Careful financial management may pull the Atchison through with some difficulty, and enable it to carry its heavy load until better times come; but its present condition is a severe lesson which will be learned by its rivals and other observers, and will be heeded—until the next "boom" comes.

THE JOHNSTOWN DISASTER.

THE story of the catastrophe in the Conemaugh Valley has been so fully told in the daily papers that it would be a waste of time to attempt to describe it in detail here. It is but a repetition on a larger scale of more than one previous accident of the kind, the disastrous results in this case being due to the fact that a large population had been concentrated around the flourishing iron and steel works situated in the narrow valley.

To give the story as briefly as possible, a dam on the South Fork of the Conemaugh, above which was a lake, or reservoir, containing some 480,000,000 cubic feet of water, gave way under the pressure of a flood caused by an unusually heavy rain. This vast mass of water swept through the narrow valley, confined by the high hills on either side, wrecking almost completely the villages and towns in its path. These included South Fork, Mineral Point, Conemaugh, Woodvale, Johnstown, and Cambria City, the two last-named including the great Cambria Iron Works, the Gautier Steel Works, and other manufactories, with a large working population attached to them. These factories and the dwellings of some 38,000 people may be said to have disappeared; and so sudden was the failure of the dam and so rapid the rush of water that hardly any warning was given, and the people generally had not time to escape, although the hills were within a short distance. The loss of life is variously estimated, but appears to have been not far from 7,000 persons; probably the numbers will never be accurately ascertained. The loss of property was enormous, and fell largely on those who were very little prepared to bear it.

Some idea of the force of the water may be gathered from the fact that 30 locomotives in the round-house of the Pennsylvania Railroad—most of them heavy mountain engines used on the steep grades between Johnstown and Altoona—were carried away for considerable distances, and up to date three of them have not been found, being probably completely buried somewhere under the mass of wreck and rubbish brought down by the flood.

The immediate cause of the accident was, of course, the extraordinary rainfall, which resulted in much damage at other points also, but the secondary and perhaps most important cause was the existence of a reservoir and the condition of its dam above the scene of the disaster.

This dam was originally constructed to form a reservoir from which water was drawn to supply the Western Division of the Pennsylvania Canal; it was about 850 ft. long, 62 ft. high in the center, 50 ft. wide on top and 300 ft. at the bottom, built of earth and stone, and provided with a waste-way or overflow at one end, 75 ft. wide and 4 ft. below the top of the dam, cut through the rock on the hillside. The lake or reservoir flooded some 450 acres, and. when full, contained about 480,000,000 cubic feet of water. The dam was completed in 1852; some five years later the canal was sold to the Pennsylvania Railroad Company, and later its use as a waterway was given up. The reservoir was then not required, and when a breach developed in it some years later it was not stopped up, and the stream was allowed to cut it away gradually, making a gap 150 ft. wide and extending down nearly to the bottom, thus reducing the reservoir to very small proportions. About 1880 the adjoining property was bought by an association, chiefly composed of Pittsburgh people, who used it for sporting purposes; they decided to restore the lake to its former proportions by rebuilding the dam.

As to its repair, or reconstruction, the testimony is somewhat conflicting, but the work seems to have been done by adding earth and stone, as in the original dam, until its former dimensions were very nearly restored. Testimony is somewhat conflicting also as to the care taken of its condition, but it is asserted that there had been some settling, so that the center was lower than the ends by several feet. It is also stated that it had been inspected from time to time by engineers of the Pennsylvania Railroad Company, who pronounced it safe.

The failure was due to the fact that the heavy rainstorm raised the level of water in the lake much faster than the waste-way could carry it off, so that water began to run over the crest of the dam, and cut away the earth —of which the dam was formed—on its exposed side. The failure occurred because those who built and those who should have maintained the dam neglected to provide these safeguards, the absolute need of which forms part of the elementary knowledge of the principles which should govern the construction of earthwork dams. Thus, in an article on this subject in the Encyclopædia Britannica, it said that "the length of the weir (of a dam) should be made sufficient for the discharge over it to pass off the inflow during a flood, so as to insure the dam against being overtopped by a rise of water in the reservoir, *which would be fatal to an earthen dam.*" Over and over again the lesson has been taught, that if there is not sufficient provision for the discharge of the water of a flood, that the overflow will "be fatal" to such structures, and yet the lesson must be emphasized by the sacrifice of thousands of lives in order to be impressed on the minds of those who assume the responsibility of building and maintaining structures of this kind. All such persons should ask themselves whether there is sufficient provision for the overflow of the greatest flood of which there is any knowledge, and then provide for a flood twice as great. In cases where an *insufficiency* may be fatal, safety can only be assured by *superabundance*, a lesson, by the way, which human nature is very slow in learning.

At Hanover, York County, Pa., another earthwork dam, for the storage of a water supply, was washed away by the same storm. The dam failed from the same causes to which the disaster at Johnstown was due; that is, the waste-way or weir was not large enough to carry off the water of the flood. A dam on the same site was destroyed in the same way only five years ago. Happily in neither case was there any loss of life, and, excepting the dams, not much to property.

No judicial investigation into the construction of the dam has been made, and it does not yet appear that any official examination has been ordered. The American Society of Civil Engineers has appointed a committee of its members, but they will, of course, have no more authority than any other persons to examine the work, although the names of the members may give weight to any report they may make.

The same remarkable rain-storm which caused the flood in the Conemaugh extended over all of Central Pennsylvania and Maryland, causing floods everywhere in that region with great damage to property, though with little loss of life elsewhere than at Johnstown. The Pennsylvania Railroad Company, whose lines cover all the flooded district, was the heaviest loser. Its main line from Harrisburgh to Pittsburgh has been blocked for nearly three weeks, losing many bridges, both large and small, and having the road-bed itself destroyed for a considerable distance. The Philadelphia & Erie and the Northern Central both suffered in the same way, and the total loss to the railroad has been estimated as high as $8,000,000. The Baltimore & Ohio Railroad also suffered damage, but very much less than the Pennsylvania, as its position was for the most part on the outskirts of the flooded region, and not directly in the center of it, as the other company's lines were.

The storm, indeed, seems to have been a sort of local blizzard, very similar to that which struck New York and the Eastern seaboard somewhat over a year ago, except that it was accompanied by rain instead of snow. Its effects were more disastrous, in fact, than those of the blizzard.

The immediate effect of the Johnstown flood will doubtless be a general overhauling of dams everywhere, and a general feeling of anxiety among people living in the neighborhood of such structures. Whether it will produce any very lasting effect in the way of providing for supervision of any kind or greater care in construction remains to be seen. The Mill River catastrophe in Massachusetts was forgotten in a few months, and the Johnstown accident—more disastrous in its results, because the efforts of the flood were concentrated—may share the same fate, and in a year will hardly be remembered, outside of the circle of immediate sufferers. Engineers may take the warning, but it is very doubtful whether they will find it any easier hereafter to persuade the capitalist or the company which builds dams to spend the money required for safe structures.

The greatest accident of the kind on record, with its thousands of lost lives and its measureless loss and suffering, will, it is to be hoped, have for result that no similar structures will hereafter be built, without the advice and supervision of a competent engineer.

COUNTRY ROADS.

THE Engineers' Society of Western Pennsylvania has taken up the question of the improvement of country roads in earnest, and at the last meeting of that Society a long report was presented by the committee to which the question was referred. The first part is largely taken up with calculations as to the value of good roads to a community, on which point there is nothing specially new to be said, since the subject has been so often gone over before. It will be sufficient to say that the result of their calculations is that a team can haul fully 50 per cent. more on a good macadamized road than on a clay road in fair condition, and that on this basis, at a low estimate, the yearly saving to the people of Pennsylvania would be not less than $2,000,000, an amount sufficient to keep some 30,000 miles of good road in repair. To this it may be added that the great majority of our country roads are usually in poor condition, and that the Committee would hardly go beyond the mark had they assumed the increased load on a properly made and kept road at a much higher percentage.

Under the present wasteful system of maintaining local roads in most of our States, the normal condition of the roads is sure to be bad, and the load hauled is not more than one-half of what a horse should be able to take on a good road. Unfortunately, the loss incurred is so distributed that very few people realize how great it is. If they did there would be a universal demand for improvement, and the small addition to the road taxes which would be required would be welcomed as an actual saving. The difficulty is to make the great majority of the voters in rural townships see and appreciate this fact.

Another part of the report calls attention to a question about which very little has so far been said in the discussion, and that is, with regard to the location of roads. It is too often the case that a road when first located by the highway commissioners, the town committee or other local authorities, is laid out without the slightest reference to engineering principles, and entirely with regard to local considerations, such as farm boundary lines. Any one who has given any attention at all to the subject can recall numerous instances where long detours have been made, hills have been climbed and unnecessary grades put in for just such reasons, and locations been made which no engineer would entertain for an instant. The local authorities in charge usually entirely ignore the fact that the capacity of a vehicle is limited by what engineers call the "ruling gradient," and that a single steep hill will cut down the load which can be hauled over a number of miles of road. They also seem to forget that while horses may be urged at such points to extra effort, and while the results may not be immediately apparent, the injury is still there, so that a badly located road will not only diminish the carrying power of all the vehicles in the neighborhood, but will also, in the end, shorten the lives of many, if not all, of the draft animals owned in the neighborhood, which should be a serious consideration to the farmer. Moreover, the injury done by a badly-located road with unnecessary grades is cumulative; it goes on year after year, increasing as the neighborhood grows, and may continue to inflict injury long after the original locators are dead and forgotten. A farmer will grumble at a toll-gate on a turnpike, and will resort to all sorts of measures either to avoid it or to have it done away with; but he does not seem to realize the fact that an unnecessary grade or an addition to the length of the road made to accommodate a neighbor's boundary line is really a toll-gate more costly than any to be found on a turnpike.

In the West and in the newer States the country roads generally follow the township and section lines, and in a fairly level country this makes but little difference. It is in the older States of the East that the greatest faults in this respect are to be found. That the statements above are not at all exaggerated could be easily proved in a day's drive in almost any district in the New England States, New York, New Jersey, or Pennsylvania.

The conditions and methods of making and repairing roads all need improvement and all deserve study, but the first step in a reform should be the employment of competent engineers to locate the roads. The instances are not few where the saving which could be effected in a single year would be enough to pay for all that the services of an engineer would cost.

The Engineers' Society of Western Pennsylvania deserves credit for taking up the matter, and it is to be hoped that interest in it will not be lost, and that its missionary efforts will be continued. With its report the Committee submitted the draft of a bill to be presented to the Pennsylvania Legislature. This bill provided for the division of roads into three different classes, according to their importance, and regulating the methods to be employed in building, repairing, and supervising each class. The details of this bill we have not had time to examine; but we believe that it embodies the principle upon which all improvement must rest—the formation of larger districts, with county or State supervision, so that the roads may be placed in charge of competent persons, who can devote their time to the business and receive proper compensation. This, with some system of general supervision by States or large districts, and the abolition of the present vicious system of "working out" road taxes, seem to us to be essential, if we are to have a really good system of country roads.

NEW PUBLICATIONS.

A Theoretical and Practical Treatise on the Strength of Beams and Columns; *in which the ultimate and the elastic limit strength of beams and columns is computed from the ultimate and elastic limit compressive and tensile strength of the material, by means of formulas deduced from the correct and new theory of the transverse strength of materials.* By Robert H. Cousins. New York; E. & F. N. Spon, 1889. (Octavo, 170 pages. Price, $5.)

The new theory of beams presented in this work is developed from certain "hypotheses" for which the Author offers no justification, either experimental or theoretical. Some of these hypotheses agree with those used in the common theory, and are well known as sound fundamental principles, while others, which form the real basis of the new theory, must be regarded with suspicion until the grounds upon which they rest are established. For instance, the hypothesis that "the sum of the moments of resistance of the fibers to compression is equal to the sum of the moments of resistance of the fibers to extension" is not an axiom, and hence requires explanation and demonstration. The theory of the Author cannot be regarded as "correct," unless its fundamental hypotheses are justified in some manner.

It is a fundamental principle of mechanics that when a free body is acted upon by two forces whose directions are opposite, motion will ensue unless the forces are of equal intensity. This principle, applied to the horizontal fiber strains in a beam, shows that the sum of the tensile stresses must be equal to the sum of the compressive stresses. It is scarcely possible that all the text-books could be in error in this principle, founded, as it is, upon universal experience, and yet the Author of the new theory states as one of his hypotheses that "the algebraic sum of the direct forces of compression and extension can never become zero."

The Author supposes that at the inception of the loading the neutral line or axis is at the bottom or extended side of the beam, and that as loads are added it moves upward. Reasoning from his "hypotheses" the position of the neutral line is determined, and at the time of rupture it is found to occupy a position depending upon the ratio of the ultimate tensile to the ultimate compressive strength. In this reasoning it is assumed that the hypothesis that the fiber strains are proportional to their distances from the neutral surface is true when the elastic limit of the material is exceeded.

The common theory of flexure is well established by comparing the computed and observed deflections of beams. The Author of the new theory does not, however, discuss the subject of deflection. The common theory is not a rational one for cases where the elastic limit of the material is surpassed, and when applied to the rupture of beams or columns its formulas are merely empirical. All of the formulas given by the Author should be regarded as of less value than empirical ones, because of their unsatisfactory theoretical foundation.

Preliminary Report on the Use of Metal Track on Railroads as a Substitute for Wooden Ties: by E. E. Russell Tratman, C.E. Report on Experiments in Wood-seasoning by the Chicago, Burlington & Quincy Railroad. Compiled by B. E. Fernow, Chief of Forestry Division, Department of Agriculture. Washington; Government Printing Office.

This pamphlet, which forms Bulletin No. 3 of the Forestry Division, is a sequel to Bulletin No. 1, issued last year by Mr. Fernow, who has, as Chief of the Division, taken an active and intelligent interest in the preservation of our forests, and who has recognized that the draft upon them for the supply of the railroad demand is one of the leading causes of their destruction.

The present report touches upon two of the chief methods of diminishing the railroad demand—the substitution of metal for wood, and the use of various processes for prolonging the life of wooden ties.

Mr. Tratman's paper is a condensed statement of what has been so far done in the use of metal abroad; for this country the statement is confined chiefly to what has been proposed, for very little has actually been done in this direction as yet.

The preservation of timber opens up a promising field, in which also there has been much more done abroad than in this country, and notes on experimental work in this direction are sure to be of service. The Forestry Division is doing excellent service, and its work should be appreciated and aided by railroad officers everywhere.

Crull's Time and Speed Chart, for the Use of Superintendents, Trainmasters, Train-Despatchers, Conductors, Engineers, Etc.: by E. S. Crull, Chief Train-Despatcher. Chicago, Ill.; Rand, McNally & Company (Price, $1).

This little book contains tables showing the time occupied to pass over a given distance at any rate of speed, from 2 up to 69 miles an hour; a separate page is given for each mile per hour, and the distance is given for each mile from 1 to 150, and also for tenths of a mile, so that the distance which a train will traverse in a given time, at almost any possible rate of speed, can be ascertained at a

glance. Such a book will be a great time-saver and exceedingly convenient in the Superintendent's office, in making up time-tables; and often more so to the Train-Despatcher, who has constant occasion to ascertain the time which special, extra, or irregular trains will take between stations at any possible rate at which they can be moved. The book deserves and will, doubtless, find a large circulation of this kind.

A HISTORY OF THE PLANING-MILL, WITH PRACTICAL SUGGESTIONS, FOR THE CONSTRUCTION, CARE, AND MANAGEMENT OF WOOD-WORKING MACHINERY: BY C. R. TOMPKINS, M.E. New York; John Wiley & Sons, No. 15 Astor Place.

The title given to this book should, perhaps, be reversed, for while 70 of its 222 pages are given up to the history of the original invention of the planing-mill and of its various improvements, and the great controversy which grew out of the Woodbury patent, the remainder is filled with very valuable and practical advice as to the construction and use of the planing-mill and other wood-working tools. The chapters under this last head include the General Construction of Machinery, Construction of Wood-working Tools, Speeding Wood-working Machinery, Adjusting New Machines, Feed-rolls, Lubrication, Moulding Machines, Difficulties of Manufacturers, Foremen and Management, Outfit for a Small Mill, Advice to Operators, Artistic Wood-work, Friction, Shafting, and Belting. In the concluding chapter there is some general and very excellent advice to young men.

Mr. Tompkins's experience of over 40 years in the construction and use of wood-working machines has enabled him to write a book which will certainly be of very great use not only to the young man beginning business, but also to the manufacturer of experience, and both classes will find in it many things that will help them.

GEOLOGICAL SURVEY OF NEW JERSEY: ANNUAL REPORT OF THE STATE GEOLOGIST FOR THE YEAR 1888. Trenton, N. J.; issued by the Survey.

This annual report is somewhat smaller than many of the preceding reports, for the reason that the geological survey is now approaching its conclusion, and the first volume of the final report has already been issued. It contains a statement of the work done by the Survey during the past year, which has been chiefly in preparing the final report and in completing the office work and maps. In addition to this statement and the usual yearly report of expenses, etc., it gives notes on the drainage of the Great Meadows in the Pequest Valley and on the drainage of the lowlands above Little Falls on the Passaic; notes on Water-Supply and Artesian Wells; a geological study of the Triassic or Red Sandstone, and statistics of the mineral products of the State for the year.

The Geological Survey of New Jersey has so high a reputation, and its publications have always reached so high a standard, that it is hardly necessary to say that the present volume is an acceptable addition to geological literature, even in the limited sphere which it necessarily covers.

BOOKS RECEIVED.

REPORT OF THE FOURTH ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS & SURVEYORS, HELD AT BLOOMINGTON, ILL., JANUARY 23-25, 1889. Champaign, Ill.; issued by the Society, Professor A. N. Talbot, Secretary.

CATALOGUE OF INTERLOCKING APPARATUS, SIGNALS, SWITCHES, ETC., MANUFACTURED BY THE UNION SWITCH & SIGNAL COMPANY. Pittsburgh, Pa.; issued by the Company. This catalogue, or rather treatise on signals, is reserved for more extended notice hereafter.

THE MICHIGAN ENGINEERS' ANNUAL, CONTAINING THE PROCEEDINGS OF THE MICHIGAN ENGINEERING SOCIETY FOR 1889. Climax, Mich.; issued by the Society, F. Hodgman, Secretary. (Price, 50 cents.)

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these papers includes the following titles: The Monte Video Water-Works, by William Galwey; Canal, River and Other Works in France, Belgium and Germany, by L. F. Vernon-Harcourt; Railway Steep Inclines, comprising four different papers by John Carruthers, Robert Wilson, Joseph P. Maxwell, and Otto Gruninger, with an abstract of the discussion on these papers; the Compound Principle Applied to Locomotives, by Edgar Worthington; Abstract of Papers in foreign transactions and periodicals.

THIRTIETH ANNUAL REPORT OF THE TRUSTEES OF THE COOPER UNION FOR THE ADVANCEMENT OF SCIENCE AND ART: 1888-89. New York; issued by the Cooper Union.

THE LOWE FEED-WATER HEATER AND PURIFIER: CATALOGUE AND DESCRIPTION. St. Louis; issued by the Pond Engineering Company. This catalogue gives a description of the Lowe feed-water heater, which has been in use for a number of years, and has been widely introduced through the West. It sets forth concisely the advantages of the heater, with the best method of using it. The Pond Engineering Company are the Western agents of this device.

ILLUSTRATED CATALOGUE OF WOOD-WORKING MACHINERY. Rochester, N. Y.; J. S. Graham & Company. This catalogue deserves especial mention for the excellence of the engravings and the completeness of the descriptions. It gives accounts of a large variety of tools manufactured by this well-known firm.

STEAM-PUMPING MACHINERY BY THE BUFFALO STEAM PUMP COMPANY: CATALOGUE AND DESCRIPTION. Buffalo, N. Y.; issued by the Company. This is a well-illustrated catalogue of their large variety of pumping-machines, and in addition has a compendium of information useful for persons who require steam pumps.

THE CONTRACTORS' PLANT MANUFACTURING COMPANY: CATALOGUE No. 3, 1889. Buffalo, N. Y.; issued by the Company. This catalogue gives a very full list of hoisting machinery, derricks for steam, horse and hand power, contractors' plows, road-rollers, dumping-cars and similar machinery made by the Company.

THE ACME AUTOMATIC SAFETY ENGINE: CATALOGUE AND DESCRIPTION. Rochester, N. Y.; the Rochester Machine Tool Works, Limited.

THE CONSTRUCTION AND USE OF THE UNIVERSAL HAND LATHE. Providence, R. I.; issued by the Brown & Sharpe Manufacturing Company.

DAVIS DRILLS AND KEY-SEATING MACHINES: CIRCULAR AND DESCRIPTION. Rochester, N. Y.; W. P. Davis, 169-171 Mill Street.

THE STANDING AND RECORD OF THE HEISLER SYSTEM OF LONG DISTANCE INCANDESCENT ELECTRIC LIGHTING. St. Louis, Mo.; issued by the Heisler Electric Light Company.

WILL STEAM-HEATED HOT WATER HEAT RAILROAD CARS? THE MCELROY APPARATUS FOR HEATING CARS. Albany, N. Y.; issued by the McElroy Car-Heating Company.

THE ERIE CAR-HEATING COMPANY: CATALOGUE AND DESCRIPTION. Erie, Pa.; issued by the Company. This is a clear and well-illustrated description of the system of steam heat-

ing introduced by the Company, which has been tried on the Lake Shore & Michigan Southern and the Pittsburgh, Fort Wayne & Chicago roads with very satisfactory results.

THE GOULD MANUFACTURING COMPANY'S CATALOGUE OF PUMPS AND HYDRAULIC MACHINERY: TWENTY-SEVENTH EDITION, 1889. Seneca Falls, N. Y.; issued by the Company.

ROGERS' PATENT SHAKING AND DUMPING GRATE BAR. Utica, N. Y.; H. Rogers.

THE FERGUSON BOILER FOR STEAM AND HOT WATER HEATING. Albany, N. Y.; issued by the Ferguson Boiler Company.

THE BUTTON STEAM FIRE ENGINE. THE BUTTON HAND FIRE ENGINE: CATALOGUES AND DESCRIPTIONS. Waterford, N. Y.; issued by the Button Fire-engine Company, Holroyd & Company, Proprietors.

THE PETITHOMME DUST-GUARD AND CAR-AXLE BOX: CATALOGUE AND DESCRIPTION. Oakland, Cal.; issued by Joseph L. Petithomme.

ABOUT BOOKS AND PERIODICALS.

THE JOURNAL of the Engineers' Society of Lehigh University for April has articles on Fuel Gas and a Graphical Solution of a Valve Gear Problem, besides the proceedings of the Society and a number of other notes of interest to the Alumni of the University.

Among the articles in the STEVENS INDICATOR for April are papers on the Design of Locomotive and Car-Springs; the Features of English Locomotive Practice, and the Inspection of Riveted Bridge Work, besides several others of value. An Electric Railroad Power Test gives a careful account of the power employed and the operating expenses of the electric railroad at Asbury Park, including some particulars of the operation which are not always easy to get from our electrical brethren.

Recent issues of the D. VAN NOSTRAND COMPANY, New York, include Machine-Drawing and Design, by William Ripper, a very elaborate work on this subject, upon which, by the way, many books have been published, but very few of any lasting value. Another recent work is Waring on Sewers and Sewerage, a book by one of the highest authorities now living. Recent issues of the Science Series, published by this Company, include Leveling, by Professor Baker; Recent Practice in Sanitary Drainage, by William Paul Gerhard; the Treatment of Sewage, by Dr. C. M. Tidy, and a revised edition of Redwood on Petroleum. This firm is now issuing a number of books on electrical engineering.

The first of the Electrical Papers in SCRIBNER'S MAGAZINE appears in the June number; it is by C. F. Brackett, and is chiefly introductory, giving an outline of the subject and a sketch of the ground to be covered by this series. This is extensive enough, and will take some time even in the popular form proposed.

The chapter of Mr. Kennan's Siberian Travels in the CENTURY for June treats of the gold mines of Kara, which are rich enough to tempt immigration, if it were not for the fact that the Imperial ownership of the mines and the convict system shut out all outside enterprise, and probably will continue to do so even when the railroad renders the mines accessible. A note on Forestry and Forest Preservation in the same number will be read with interest.

The paper on the Historical Capital of Iowa, by Mrs. Dye, in the MAGAZINE OF AMERICAN HISTORY for June, deals incidentally with the many and great changes made in the West, by the progress of railroads. But it may be a question whether Iowa City has not done better service as the educational capital of the State, and the seat of the State University, than it would have done had it remained simply the political capital.

One magazine must be considered as having—perhaps not intentionally—discouraged railroad travel. In OUTING, for June, the pleasures and advantages of journeying on horseback, by bicycle, and by canoe are set forth so attractively as to tempt the reader to give up the railroad at once, for one or all of these more athletic modes of travel.

In California just now there is no more interesting question than that of irrigation, and an article on that subject by John Bonner, in the June number of the OVERLAND MONTHLY, will attract attention. It is a clear statement of the necessity of some intelligent control of the question to prevent the waste of resources, which must be carefully husbanded, if they are to be properly utilized. The plan for the regulation of the matter by the general Government is a fair one, but it is doubtful whether the people—on the Atlantic coast at least—are yet ready to have the Government undertake the expense of extensive irrigation works at present, however necessary they may be to the local prosperity of the Pacific slope.

Something of the feeling which exists there and of the irritation which is sometimes caused by Eastern ignorance and apparent want of interest finds expression in another article in the same number on a Pacific Coast Policy, the writer of which is, perhaps, inclined to put his case rather strongly, but which nevertheless deserves reading.

In HARPERS' MAGAZINE for July there is an interesting article on Glass Manufacture, profusely illustrated.

In the POPULAR SCIENCE MONTHLY for June Mr. Almy's paper on the Production of Beet Sugar has much to say of the machinery used in that industry, which is interesting to a mechanical engineer. An article by Dr. Zacharias on the Animals Found in Well Water deserves careful reading by the sanitary engineer. In the July number is an article on Railroad Maladministration, by Benjamin Reece, treating of the over-building of railroads, with the consequent loss either to investors or the public.

UNITED STATES NAVAL PROGRESS.

THE Navy Department has issued proposals for the three 2,000-ton cruisers, the plans for which are described below. Four classes of bids were asked for:

1. For a vessel in accordance with the plans of the Department for both hull and machinery.
2. For a vessel to be built on plans, for both hull and machinery, to be furnished by the contractors.
3. For a vessel, the contractor to furnish plans for the machinery, the hull to be built on plans of the Department.
4. For a vessel, the contractor furnishing plans for the hull and using the Department plans for the machinery.

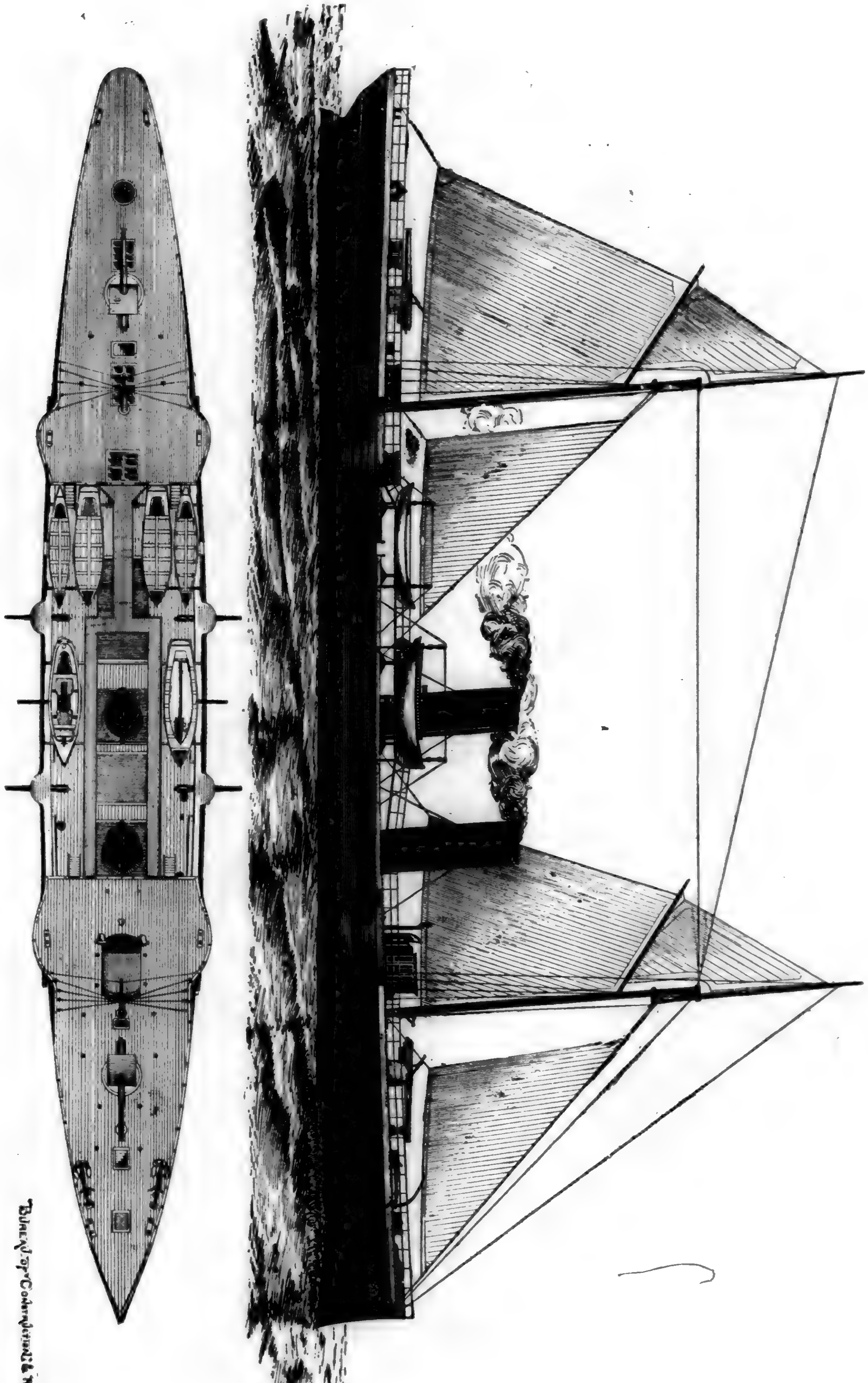
The bids will be received until August 22, 1889. The cost of these vessels is limited by law to $700,000 each.

The accompanying illustration, for which we are indebted to the *Army and Navy Register*, shows a side-view and deck plan of the new 2,000-ton cruisers, for which plans have been prepared. These vessels were described in the June number of the JOURNAL, but for convenience the description is here partially repeated.

The chief dimensions are: Length on load water-line, 257 ft.; extreme breadth, 37 ft.; depth of hold to under side of spar-deck amidships, 19 ft. 6 in.; mean normal draft, 14 ft. 6 in.; displacement to load water-line, 2,000 tons; tons per inch at load water-line, 15¼; area of immersed midship section, 665 sq. ft.; transverse metacenter, 7 ft. above center of gravity.

These vessels are to be twin-screw, protected cruisers with poop and forecastle decks and open-gun decks between, fitted with water-tight decks of 17½ lbs. plating at sides, reduced to 12 lbs. in the center, extending the entire length of the vessels. This deck is to be below the water-line at the sides 36 in., and all the machinery, magazines, and steering apparatus are to be below it. The rig is to be that of a two-masted schooner, bearing a small spread of canvas.

The motive power for each vessel is to be furnished by



Bureau of Construction & Repair

DESIGN FOR NEW 2,000-TON CRUISERS, UNITED STATES NAVY.

two triple-expansion engines of 5,400 H.-P., with cylinders of 26½, 39, and 63 in. in diameter and 33 in. stroke. The engines and boilers are to be placed in separate water-tight compartments. The crank-shafts are to be made interchangeable. All framing, bed-plates, pistons, etc., are to be of cast steel. The boilers are to be five in number, made of steel, and designed for a working pressure of 160 lbs. They are to be of the return-flue tubular type. Three are to be double-ended and two single-ended. The latter are to be used as auxiliaries, but when steaming full power they can be connected with the main engines. The vessels are to attain a speed of 18 knots under forced draft. The normal coal-supply will be 200 tons, with a bunker capacity of 435 tons. The coal will be stored so as to give all possible protection to the ship.

The entire main batteries are to be composed of rapid-fire guns as follows: Two 6-in. rapid-fire breech-loading rifles, mounted on forecastle and poop decks, and eight 4-in. rapid-fire breech-loading rifles, mounted four on each broadside. The secondary batteries are each to contain two six-pounder rapid-fire guns, two three-pounder rapid-fire guns, two revolving cannons, and one Gatling gun. The torpedo outfit of each vessel will be six torpedo tubes for launching automobile torpedoes, one each at the stem and stern and two on each side. There will be a complete outfit of boat spar-torpedo gear and charges. A conning-tower, oval in shape, is to be located on the forecastle deck, being 7½ ft. athwartships by 4 ft. fore and aft, and 5 ft. 4½ in. above the deck. It is to be fitted with steam steering-wheel, engine-room telegraphs and speaking-tubes. A wooden pilot or chart-house is to be fitted forward of the conning-tower for ordinary use when not under fire. The ventilation, drainage, and electric-lighting systems are to be unusually good.

Means are provided for securing natural and artificial ventilation in the living and storage spaces, utilizing frame spaces, together with louvres and cowles fitted along the top, sides, and such ducts as are necessary to effect communication with the spaces below. Automatic valves are fitted in ventilating pipes, where they pass through water-tight bulkheads to prevent the flood of water from one compartment to another. Escape for the explosive gases generated in the bunkers is provided for by means of inlet and outlet pipes, and trunks leading to the funnel casings.

There is a complete steam-pumping arrangement, fitted to be used for bilge drainage or fire purposes; also, 7½-in. and 5½-in. hand pumps for draining the water-tight compartments, engine and shaft bearers, platforms, etc., delivering overboard or into the fire-main. The fire-main is worked nearly the whole length of the ship, and can be charged with water at a high pressure from the steam pumps, being also connected with hand pumps, and fitted with the necessary nozzles and hose.

The pneumatic gun carriage, made by the Pneumatic Gun Carriage & Power Company of South Boston, Mass., was fully tested June 12, at Annapolis, at the naval proving grounds, by the board of naval officers. In the test 20 rounds were fired, 10 slowly and 10 fast. The gun was furnished by the Government, and is an 8-in. gun, carrying a 250-lbs. shell, with a charge of 126 lbs. of powder. The carriage acted in a satisfactory manner. The recoil of the gun is received upon an air cushion. A short recoil is a great desideratum on shipboard, where there is little room. The pneumatic gun carriage tried reduced the recoil to 2 ft. No accident of any kind happened during the tests. The 10 fast shots were made with 1½ minutes interval.

The Navy Department invites proposals for the two steel cruisers of 3,000 tons displacement, the construction of which was authorized by the last Congress. The price fixed for these vessels is $1,100,000, and the contractors are to guarantee a speed of 19 knots, receiving a bonus of $50,000 for each quarter-knot over that speed, or forfeiting $50,000 for each quarter-knot below it. Two years is to be allowed to build these vessels. These ships will be 300 ft. long, 42 ft. wide, and 18 ft. draft; they will be armed with 6-in. and 4-in. rapid-fire guns. Bids will be received for vessels on the Department plans, or on contractors' plans.

Bids for these ships will be received until August 22. The time for receiving bids for the 2,000-ton cruisers has been fixed at the same date, August 22 next.

It is probable that the monitor *Puritan*, which for years has been a monitor only in name, never having been supplied with turrets or guns, will be transformed into an armored vessel of modern type and of great power, and that her recent trip from Norfolk to New York was ordered by Secretary Tracy with a view to placing the vessel in a yard where the important work yet to be done can be most speedily executed and to the best advantage. A board composed of Commodore Walker, Chief of the Bureau of Navigation; Commodore Schley of the Bureau of Equipment, Commodore Sicard of the Ordnance Bureau, Commodore White, Commodore Wilson of the Construction Bureau, and Chief Engineer Melville has been in session at the Navy Department, in accordance with instructions from Secretary Tracy, to consider plans for the completion of the *Puritan*.

The proposition formally submitted, and which will probably be accepted without extensive amendments, departs considerably from the original plans, which contemplated the construction of an ordinary double-turreted monitor. The turrets will be replaced with covered barbettes. This will, it is expected, increase the fighting power of the guns, by giving them a more elevated position, while the permanent wall of steel above which the guns revolve will not be subject to the influx of water as would a turret. The guns are to be increased in size from 10 to 12 in. caliber; a superstructure is to be erected amidships, which will make the vessel more comfortable, and which will also serve as a basis for a secondary battery of powerful rapid-fire and machine guns. To allow for this increase in the weight of ordnance, it is proposed to reduce the thickness of the armor belt considerably below the water-line, while slightly increasing its thickness above, and to dispense with two boilers. This last change would not affect the steaming ability of the vessel, as it contemplates the equipment of the remaining boilers with apparatus for supplying forced draft, thus more than making good the deficiency caused by the reduction in the number of boilers.

COUNTERBALANCING LOCOMOTIVES.

To the Editor of the Railroad and Engineering Journal:

IN the June number of your JOURNAL, in an article entitled Counterbalancing Locomotives, the writer states: "No one will, I think, question that the resisting forces (back-pressure, compression, and lead) are prime factors in counterbalancing an engine properly." I do, however, question most seriously the truth of the above statement, and claim that the propelling and resisting forces have nothing whatever to do with the counterbalancing of the inertia of the reciprocating parts of a locomotive. The tendency of the aforesaid inertia is to revolve the entire mass of the locomotive about a vertical axis through its center of gravity; if now we place in the wheel, opposite the crank-pin, and at same distance from center of axle, a mass equal in weight to that of the reciprocating parts on that side, its horizontal throw when the crank is on its center would exactly balance the throw of the piston, cross-head, etc., and so counteract the nosing tendency. This inertia has for its leverage the distance from midway between the rails to the middle of the main-rod crank-pin bearing, or the horizontal distance from the center line of the engine to the center line of the cylinder. If now, for example, the back pressure at the end of the stroke should be equal to half the inertia, this would reduce the pressure on the crank-pin one-half; but this resisting force also acts on the cylinder head in the same direction as the movement of the piston, and consequently, the leverage being the same, the tendency to rotate the locomotive about a vertical axis will be identical whether there is a resisting force or not. Therefore the counterweight will have the same work to perform in either case, and the introduction of a resisting force will in nowise counteract any part of the inertia of the reciprocating parts, in so far as the effect of the same on the whole machine is concerned.

E. H. DEWSON, JR.

St. Joseph, Mo., June 6.

A PARIS SUBURBAN LINE.

(Condensed from *Le Genie Civile.*)

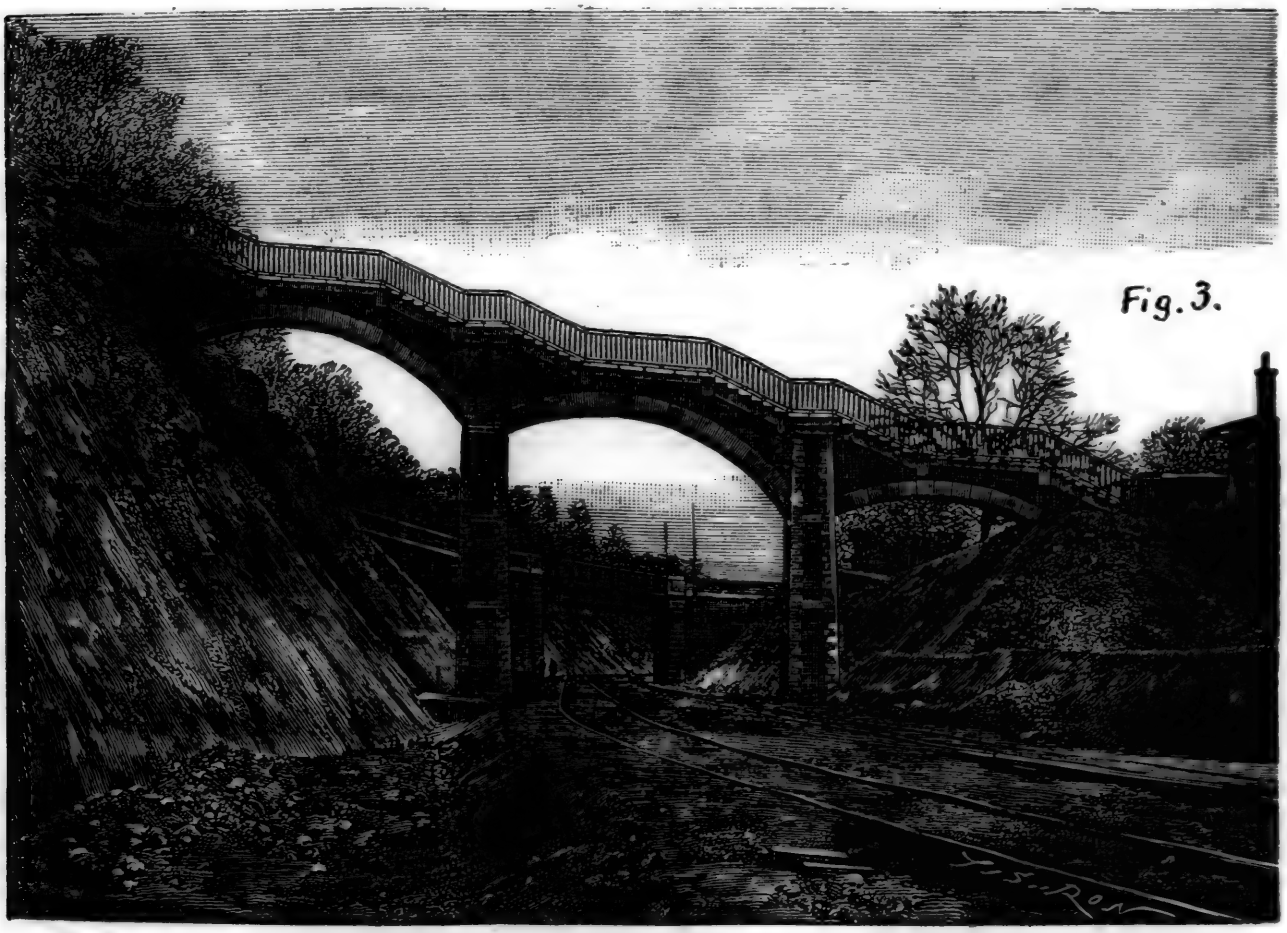
On May 1 a new city line was opened in Paris, called the Moulineaux Line, which extends from a point in the suburbs, on the left bank of the Seine, just above the city, to the Champ de Mars. This new road is a section of the line which is to run from the Bridge of the Alma to Courbevoie, following the line of the Seine and forming a sort of horse-shoe road around the city. The concession for the line was given to the Western Railroad Company in 1875, and in 1878 a section from Grenelle to the Champ de Mars was opened, but the completion of the rest of the road was delayed by various causes. The original location was modified in many places, and work was really commenced only in 1886; slowly at first, but it was afterward pushed in order to complete it before the opening of the Exposition of this year.

The construction of this line presented serious difficulties, especially in the section running along the Seine between the river and the large number of factories on the left bank. Besides a number of bridges and other works required at the crossings of the numerous railroads and streets which were met with, it was necessary, not only to avoid interference with these factories, but also to prevent too great an expense for right-of-way, to so locate the road as to avoid interfering with existing buildings, and thus to occupy a very narrow space along the bank of the river. In three places it was necessary to tunnel in order to carry the road through. It must be remembered also that the engineers had to locate the road so as to put the track above the level of the highest floods in the Seine, taking the freshet of 1876 as a standard, and, at the same time, if possible, to pass under the roads and railroads running to the bridges over the river.

The line is really a city or metropolitan line, and it is probable that it will be hereafter one branch of the Metropolitan Road, which is to be built in Paris, if an agreement can ever be reached as to the line to be adopted.

The Moulineaux Line leaves the Versailles Railroad close to the Puteaux Station, crosses the low grounds on a masonry viaduct, and then gradually descends toward the valley of the Seine, passing through Suresnes by a tunnel 335 meters long; it then gradually approaches the river, reaching its bank at the Bridge of St. Cloud, and thenceforth following it very closely to the terminus at the Champ de Mars. The extension from that point to the Bridge of the Alma is to be built next year. The total length of the road now open is 14 kilometers (8.7 miles). The minimum radius of curvature is 350 meters (1,148 ft.), and the maximum grade is one per cent. The line is chiefly remarkable for the large number of bridges and the extensive masonry works required for its completion.

Generally speaking, the obligation which the engineers were under of not altering in any way the line of the public streets met with, compelled them to make nearly all the bridge structures on the line skew bridges, and also limited them very much in the conditions of height, depth of truss, etc. Thus one bridge was set at a skew of 28°, while in the construction of the tunnel crossing at St. Cloud a system of metallic roofing with parabolic girders was adopted.



ROAD-CROSSING BRIDGE, BAS MEUDON, FRANCE.

The longest bridge on the line, the Billancourt Bridge, is also the only straight bridge. This bridge has a total opening of 60 meters (196.8 ft.), and carries the road over several streets, which meet at that point. It is a lattice girder in three spans, and in order to diminish as much as possible the depth of the girders, the cross-beams carrying the floor rest upon the lower chords. A sketch of this bridge will be found herewith, fig. 1 showing an elevation, and fig. 2 a cross-section.

A more difficult work was a bridge at Meudon, which is on a skew of 35°, and which carries over the railroad a street which at that point has a grade of 5.5 per cent. This bridge is a plate-girder bridge, the girders being joined by heavy cross-braces, and carrying brick arches

upon which the roadway is supported. The sharp skew of this bridge required a very careful and detailed study of the abutments, in order to get at the shape of the large stones at the angles.

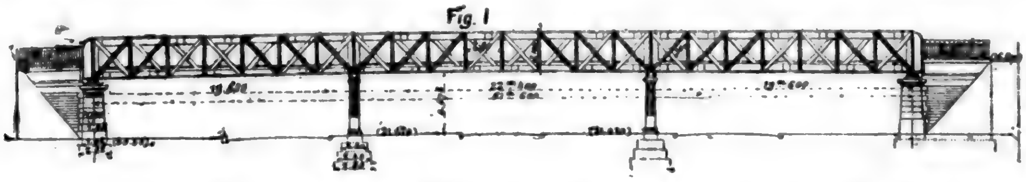


Fig. 1

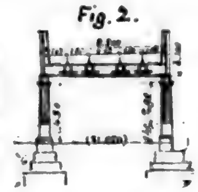


Fig. 2.

Among the masonry works on this line are two which are altogether original. These are two foot-bridges, or rather stairways, thrown across the railroad at Bas-Meudon, carrying two small streets, the Rue de la Verrerie and the Ruelle des Bœufs. The sharp transverse slope of the ground at this place, and the obligation to keep open the two small streets, required this solution. The Chief Engineer of the line did not hesitate to approve for these works a type hardly conforming to classic models. They are, however, very elegant in appearance, and complete in a happy fashion the long retaining walls required at that point. The foot-bridge at the Rue de la Verriere is shown in the accompanying illustrations, fig. 3 being a perspective, while a section of the bridge is shown in fig. 4.

In this bridge there are three arches, two of them 9.60 meters (31.5 ft.) between centers of the piers, and the third 9.10 meters (29 8 ft.). The central opening, supported by two piers of unequal height—8.81 and 6.32 meters—gives passage to the two tracks of the railroad, and the two outer arches rest on abutments founded on the bank. The arches do not spring from the same level, but, on the contrary, follow the general fall of the roadway. The foot-way, which is provided on each side with an iron railing, is in the form of staircases, divided by three level sections corresponding respectively to the centers of the three arches.

The other works on this line include a number of very heavy retaining walls, which were needed at different points on account of the light nature of the soil in the neighborhood of the river, and the impossibility at several points of securing sufficient width for a proper slope. These walls, however, present no very special features, and are merely remarkable for their extent and cost.

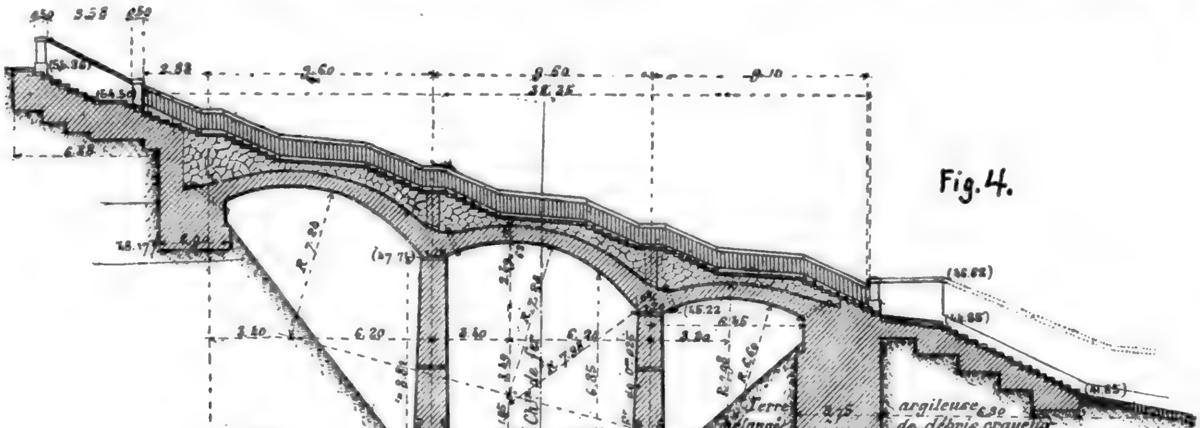


Fig. 4.

The stations on the line also, while involving considerable expense for their construction, and while they are, like most of the Paris stations, solid and elegant buildings, present no features requiring special notice.

There were necessarily made on the line several grade crossings of streets at points where they could not be avoided; these grade crossings are all provided with watchmen and with gates worked in the usual way by hand, with the exception of the crossing of the Avenue Eugenie at St. Cloud, where there are rolling gates worked from a distance by wire ropes; these gates are kept in equilibrium by counterbalanced weights in such a way as to require a very small expenditure of power to move them.

The location of the line and the design of the works was due principally to M. Lecomte, Chief Engineer of the Western Railroad, and the road was built under the immediate direction of M. Clerc, Chief Engineer of Construction for that Company.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page* 283.)

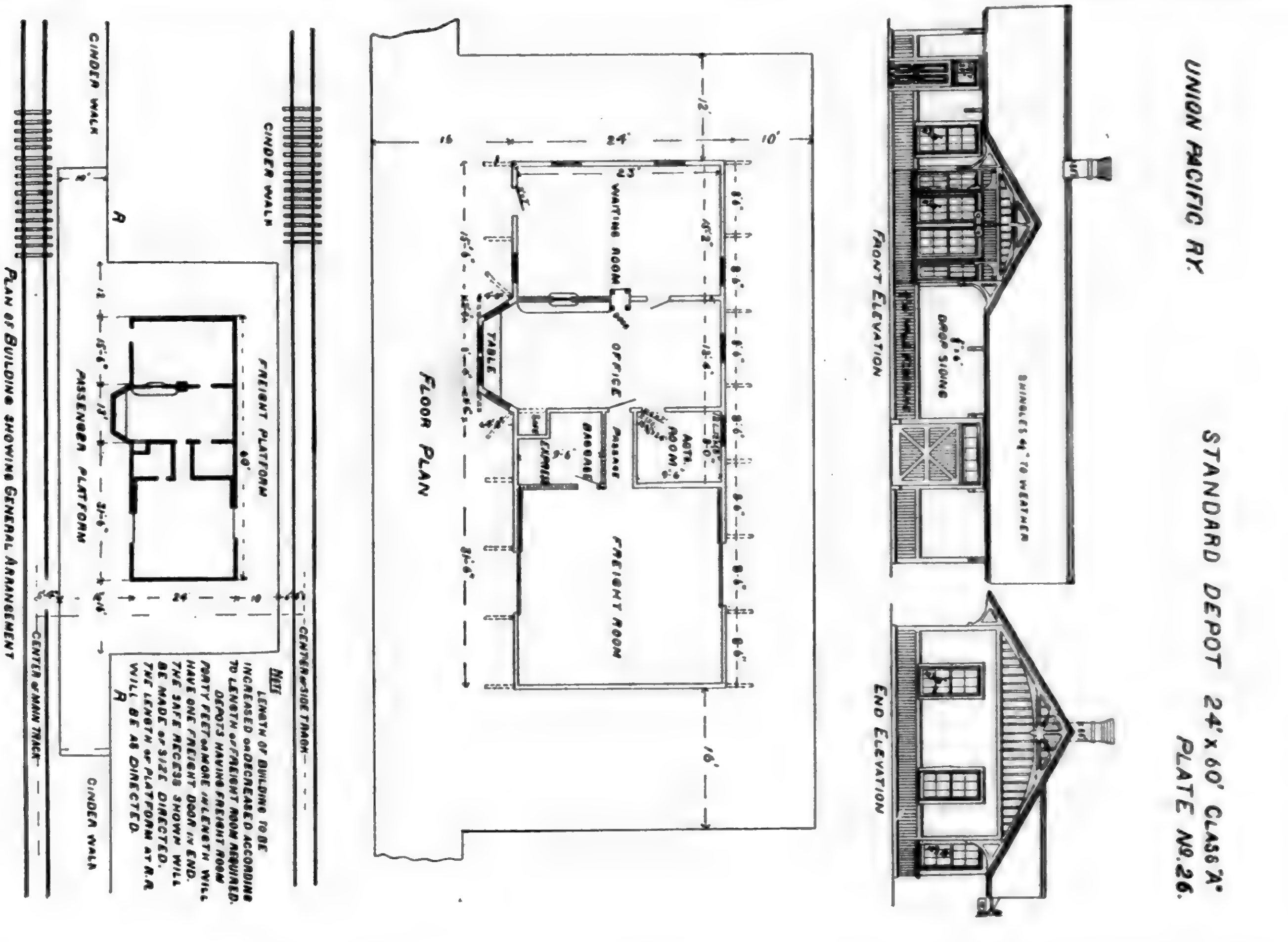
CHAPTER XI.

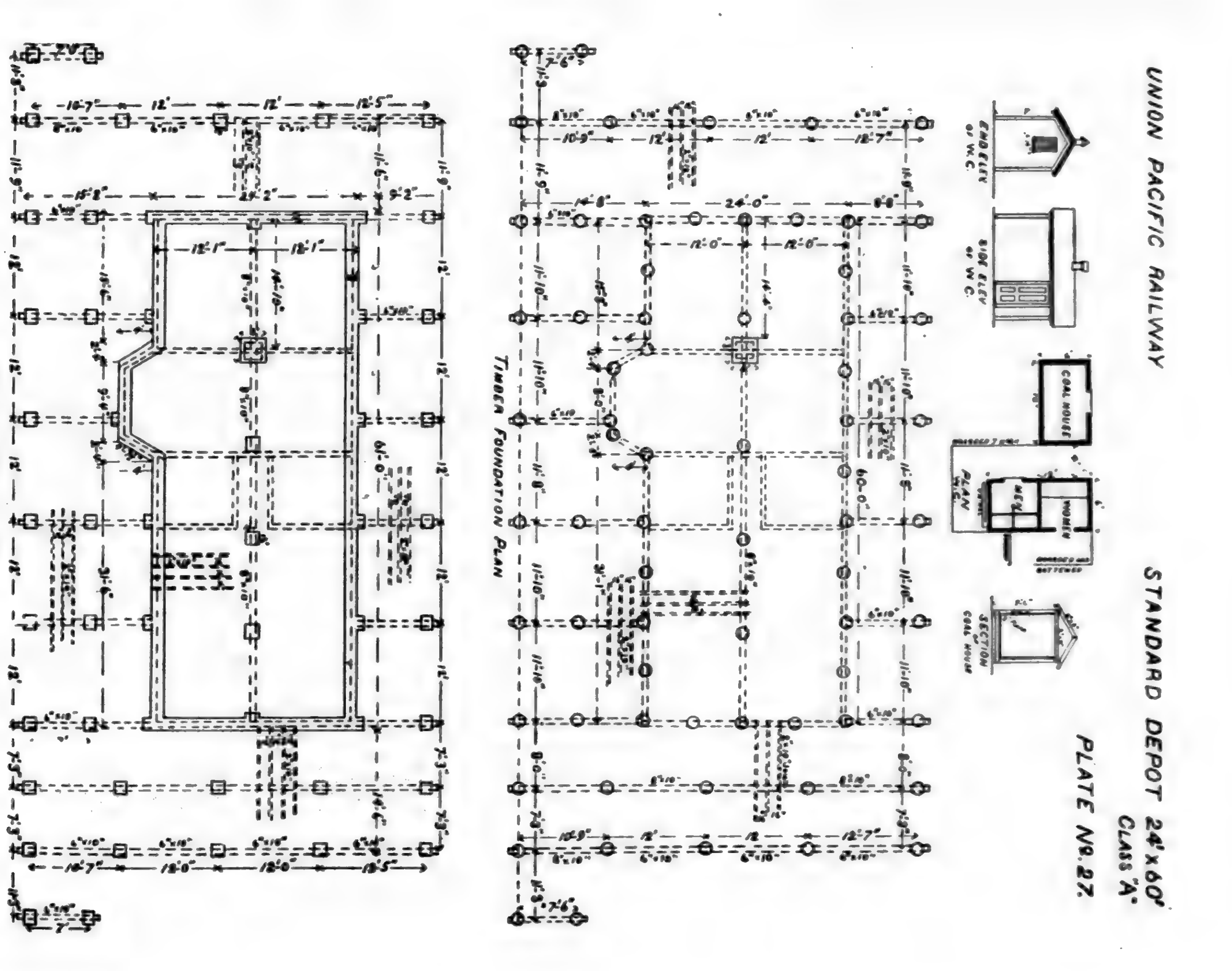
SMALL STATIONS.

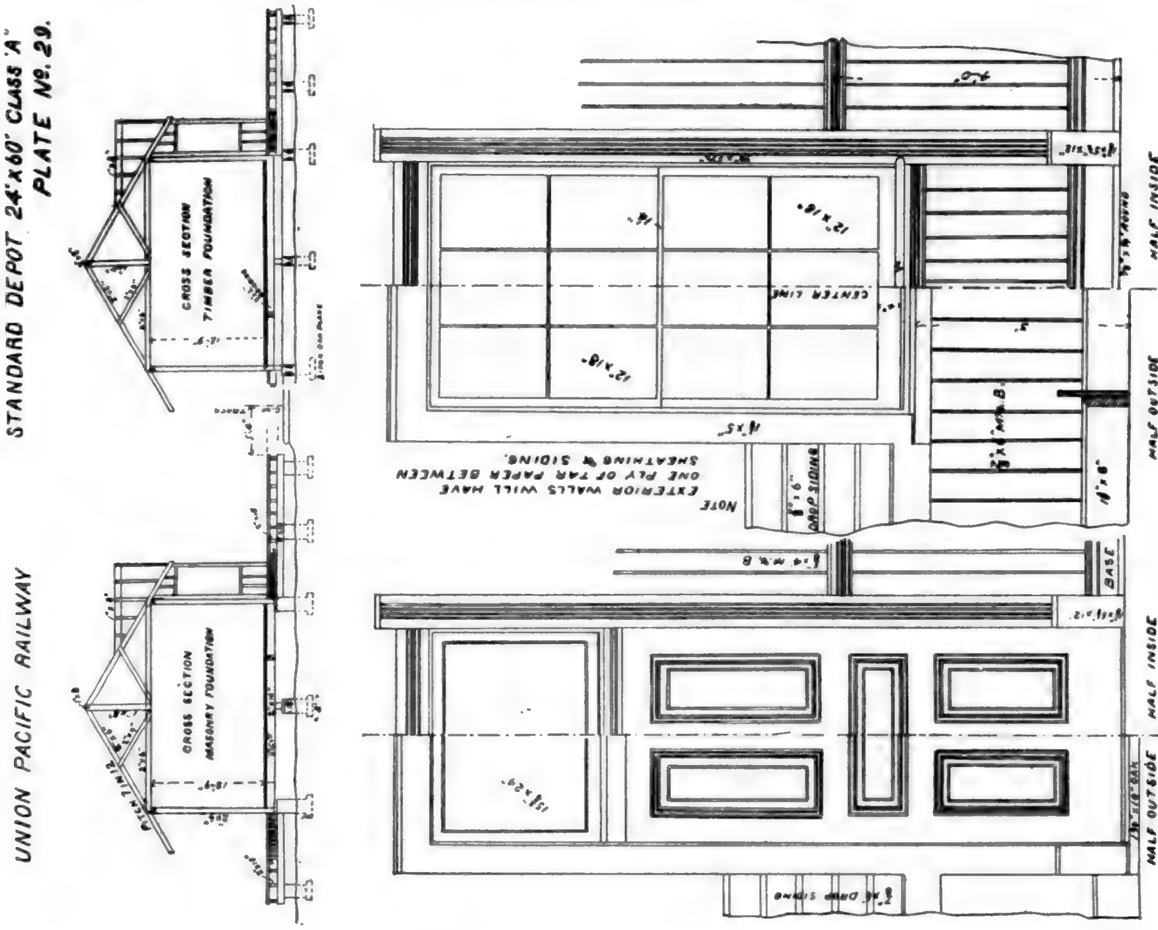
The requirements of small stations are usually about as follows: There should be one large room that can be used for freight and baggage; an office in which the agent keeps his books and performs his clerical duties; a waiting-room for the accommodation of passengers, and a women's toilet. Of course these different requirements can be contracted or expanded to almost any degree, to suit the special requirements of any one station.

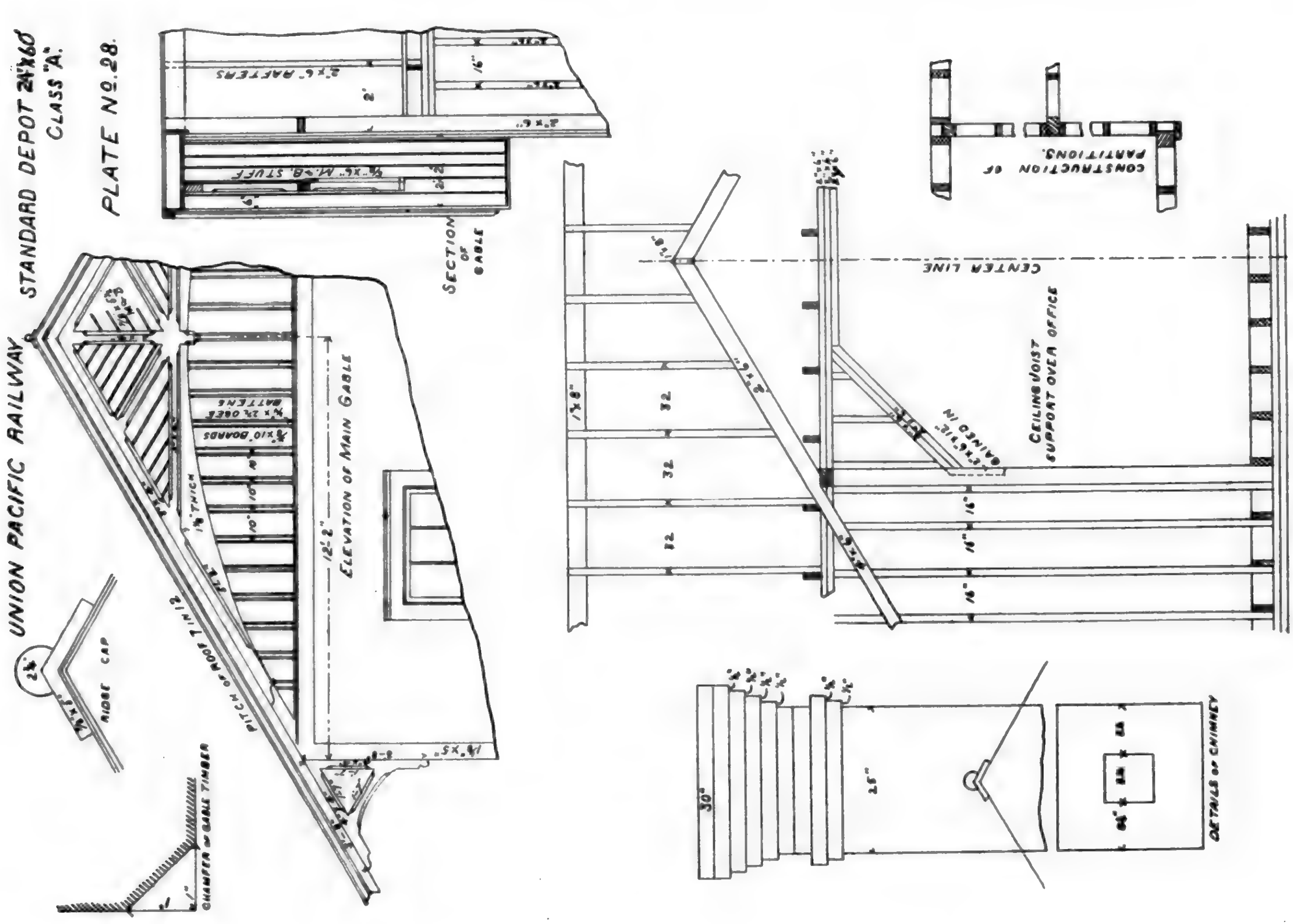
The freight-room is required for storing the freight that is received for sending away, and also that which is awaiting delivery at the place where the station is. It must also be of sufficient size to allow the receiving and storing of passengers' baggage, and usually some portion of this room is partitioned off for the storage of the express matter, and for the use of the express companies. At any station where considerable freight business is done, it is in every way preferable to have the freight-house entirely distinct from the passenger station, and they should be combined in one building only at places where the freight is of very little importance, and there is very little of it. The many disadvantages connected with having the freight and baggage-room under one roof will be taken up further on.

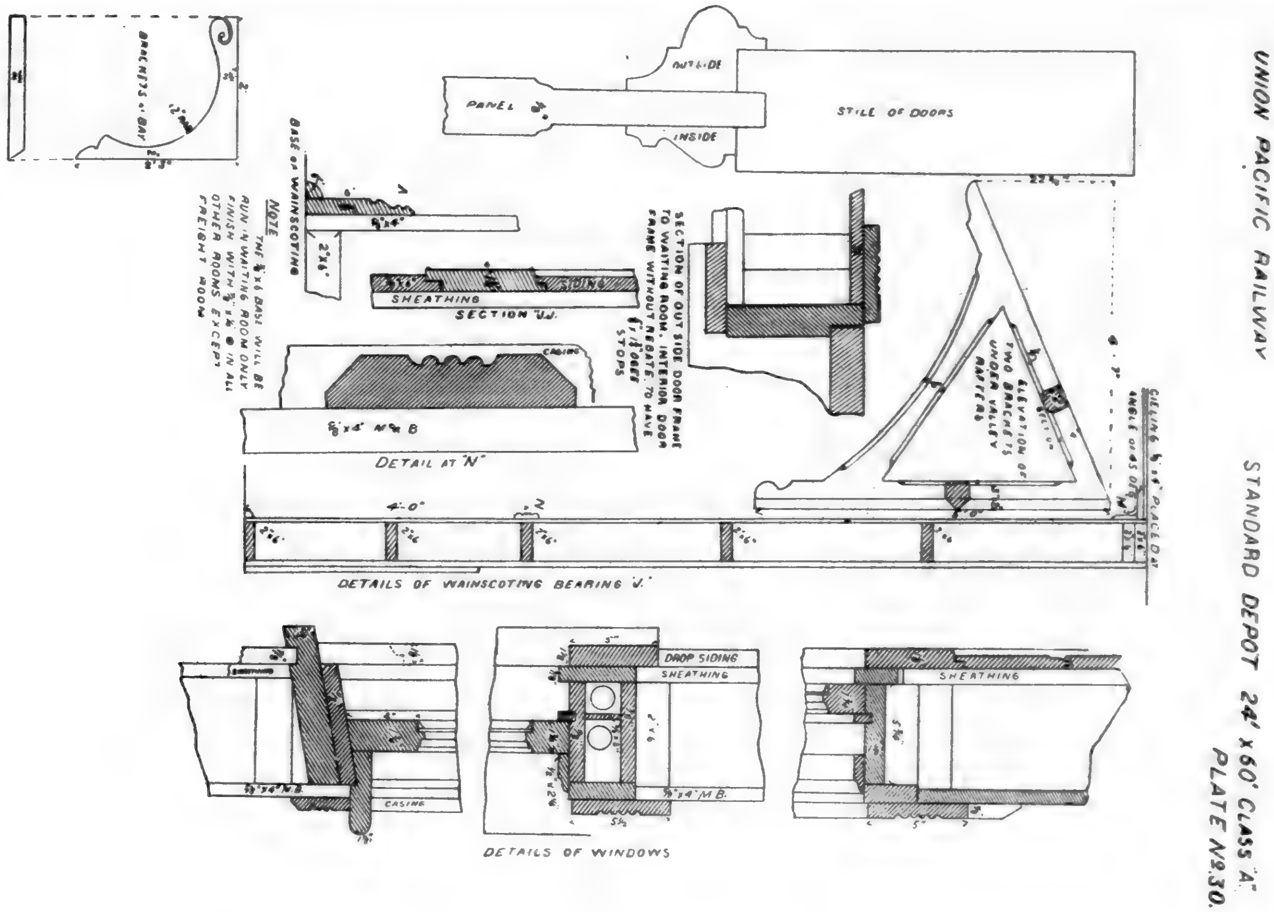
The office of these passenger stations is for the use of the station agent. It contains the tickets, the safe, all the papers and books connected with his clerical work, and

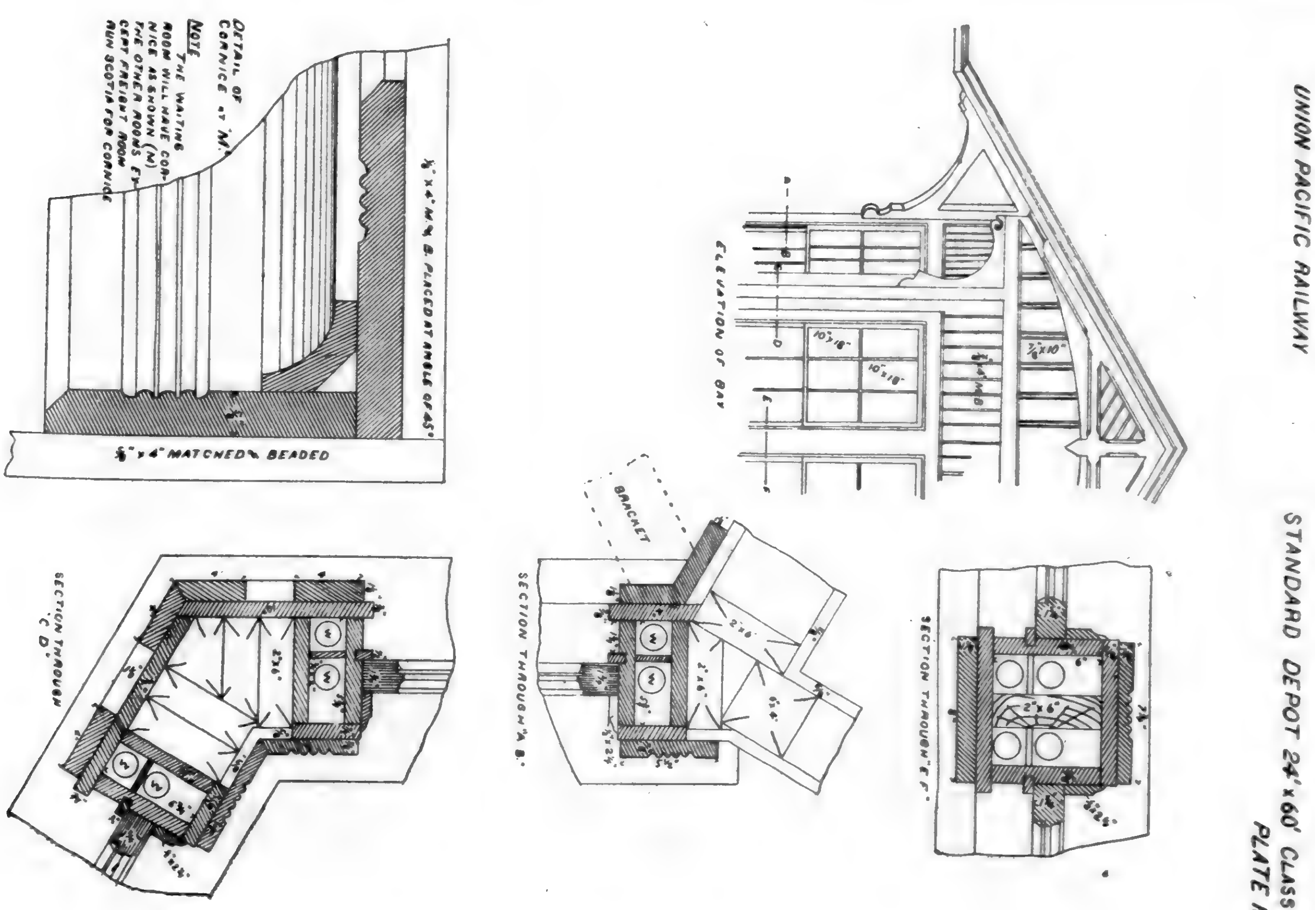

UNION PACIFIC RY.
STANDARD DEPOT 24'x60' CLASS "A"
PLATE No. 26.
SHINGLES 4½" TO WEATHER
DROP SIDING
FRONT ELEVATION
END ELEVATION
WAITING ROOM
OFFICE
TABLE
PASSAGE
BAGGAGE
EXPRESS
AGT'S. ROOM
FREIGHT ROOM
FLOOR PLAN
CINDER WALK
FREIGHT PLATFORM
PASSENGER PLATFORM
CENTER of SIDE TRACK
CENTER of MAIN TRACK
PLAN of BUILDING SHOWING GENERAL ARRANGEMENT
NOTE
LENGTH OF BUILDING TO BE INCREASED OR DECREASED ACCORDING TO LENGTH of FREIGHT ROOM REQUIRED. DEPOTS HAVING FREIGHT ROOM FORTY FEET or MORE IN LENGTH WILL HAVE ONE FREIGHT DOOR IN END. THE SAFE RECESS SHOWN WILL BE MADE of SIZE DIRECTED. THE LENGTH of PLATFORM AT R.R. WILL BE AS DIRECTED.

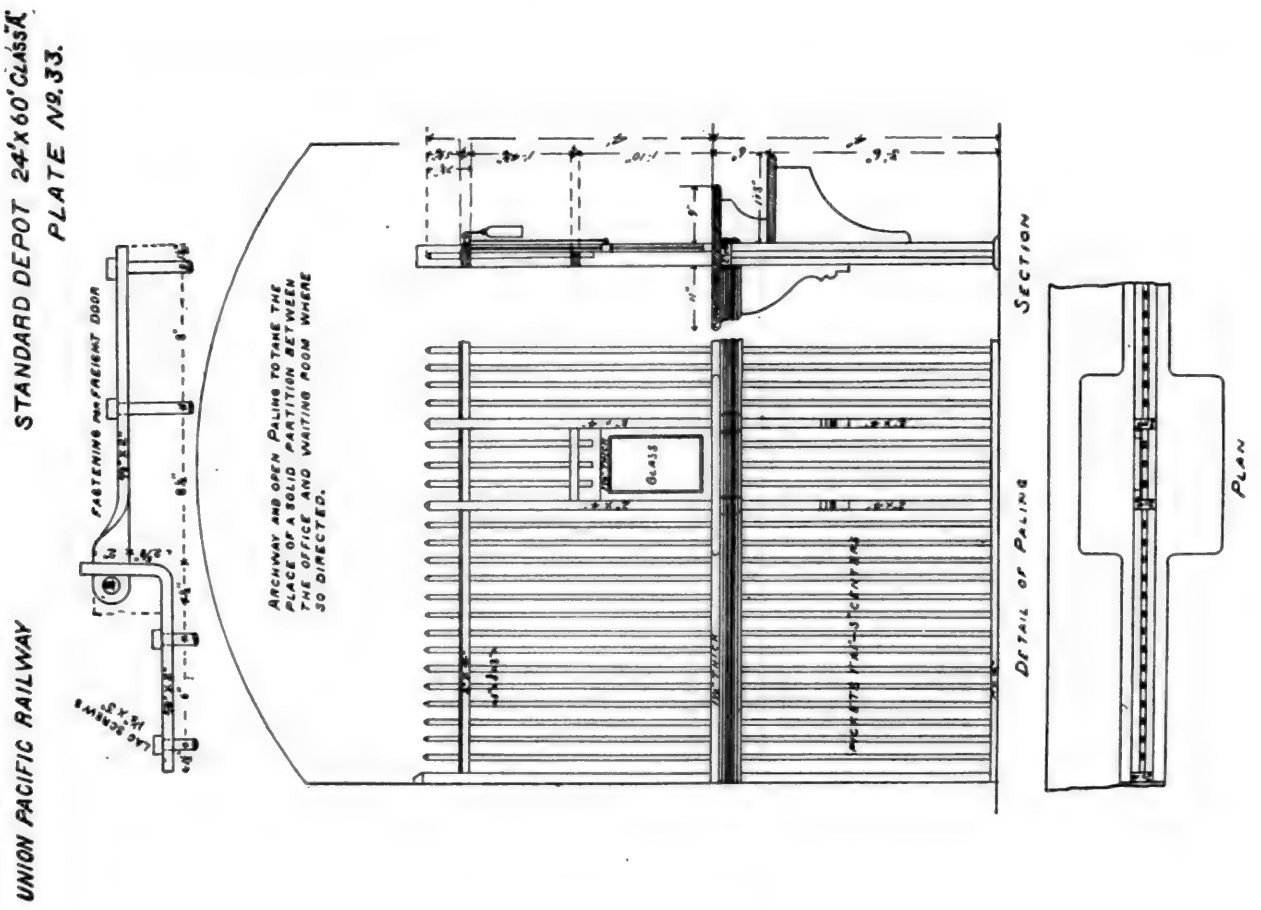

UNION PACIFIC RAILWAY
STANDARD DEPOT 24'x60' CLASS "A"
PLATE No. 27.
END ELEV. of W.C.
SIDE ELEV. of W.C.
COAL HOUSE
PLAN W.C.
WOMEN
MEN
SECTION of COAL HOUSE
TIMBER FOUNDATION PLAN
MASONRY FOUNDATION PLAN


UNION PACIFIC RAILWAY
STANDARD DEPOT 24'x60' CLASS 'A'
PLATE No. 29.
CROSS SECTION TIMBER FOUNDATION
CROSS SECTION MASONRY FOUNDATION
NOTE
EXTERIOR WALLS WILL HAVE ONE PLY OF TAR PAPER BETWEEN SHEATHING & SIDING.
CENTER LINE
HALF OUTSIDE
HALF INSIDE
ELEVATION OF WINDOW
OUTSIDE DOOR 3'x7'x1¾"
BASE

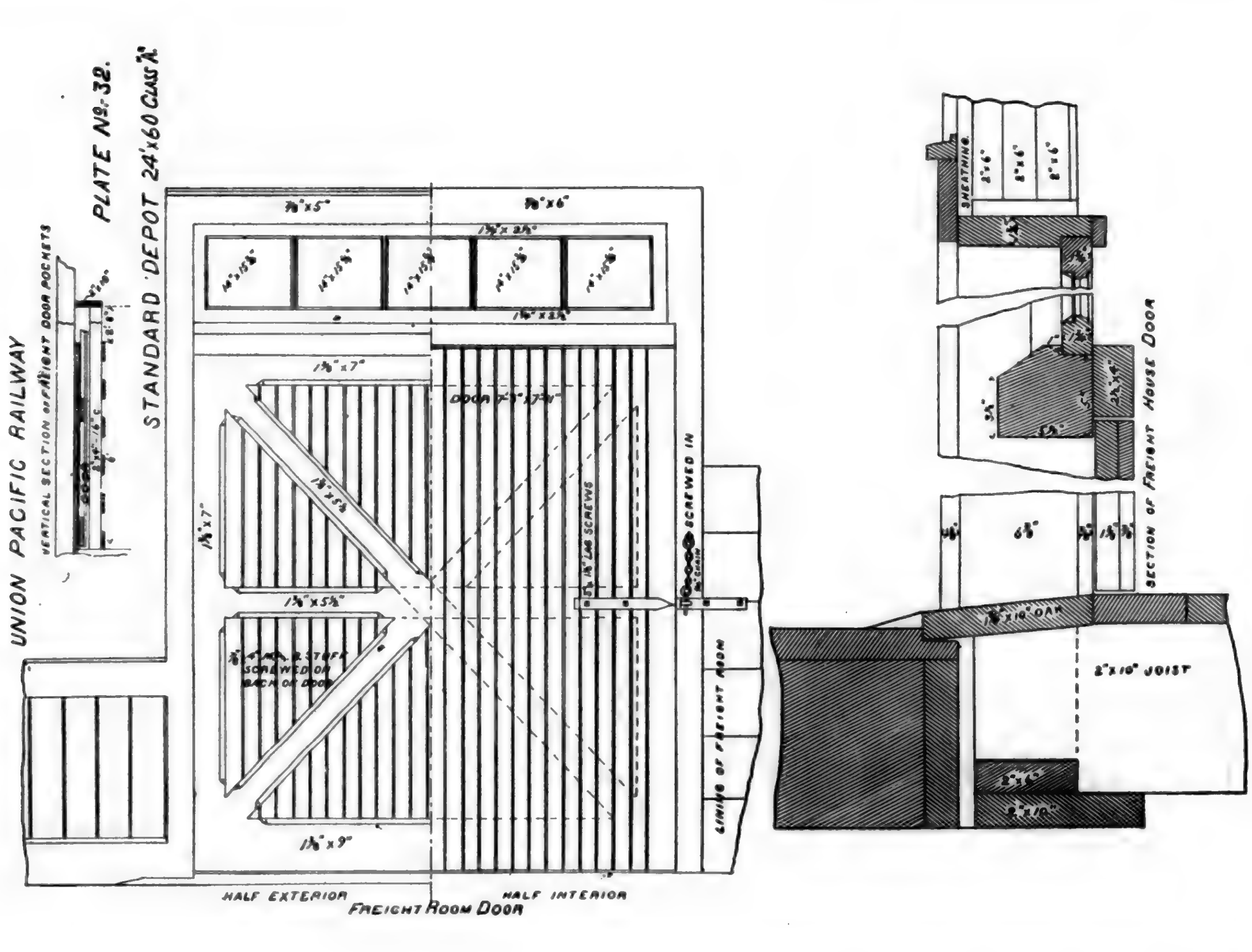

UNION PACIFIC RAILWAY
STANDARD DEPOT 24'x60' CLASS "A".
PLATE No. 28.
2"x6" RAFTERS
SECTION OF GABLE
ELEVATION OF MAIN GABLE
PITCH OF ROOF 7 IN 12
RIDGE CAP
CHAMFER OF GABLE TIMBER
CONSTRUCTION OF PARTITIONS.
CENTER LINE
CEILING JOIST SUPPORT OVER OFFICE
DETAILS OF CHIMNEY


UNION PACIFIC RAILWAY
STANDARD DEPOT 24' x 60' CLASS 'A'
PLATE No. 30.
PANEL
OUTSIDE
INSIDE
STILE OF DOORS
BASE OF WAINSCOTING
SHEATHING
SIDING
SECTION "U-U."
DETAIL AT "N"
DETAILS OF WAINSCOTING BEARING "U."
DROP SIDING
SHEATHING
CASING
DETAILS OF WINDOWS


UNION PACIFIC RAILWAY
STANDARD DEPOT 24' x 60' CLASS 'A'
PLATE No. 31.
DETAIL OF CORNICE AT "M"
NOTE
THE WAITING ROOM WILL HAVE CORNICE AS SHOWN (M) THE OTHER ROOMS EXCEPT FREIGHT ROOM RUN SCOTIA FOR CORNICE
⅞" x 4" MATCHED & BEADED
ELEVATION OF BAY
BRACKET
SECTION THROUGH "C-D"
SECTION THROUGH "A-B"
SECTION THROUGH "E-F"



UNION PACIFIC RAILWAY
STANDARD DEPOT 24'x60' CLASS "A"
PLATE No. 33.



UNION PACIFIC RAILWAY
PLATE No. 32.
STANDARD DEPOT 24'x60' CLASS "A"

usually the telegraph table and the telegraph operator. This office should be upon the side of the station facing the main track, and the usual way is to have the telegraph table located in a bay window projecting well from the side of the station, with glass all around, so that the operator, sitting at his table, has a view a certain distance up and down the main track, or anyway can take in the greater part of the yard and side tracks. The advantages of this are obvious. Arrangements should also be made so that the operator, without moving from his table, can manipulate all the signals necessary for stopping and starting trains at that station.

Running along the front of the station, between the building and the main track, there should be a broad platform, as shown in the drawings, for the accommodation of passengers and the movement of baggage, as the baggage, for trains going in one direction at least, will usually have to be moved the whole length of the platform.

The waiting-room is for the accommodation of passengers waiting for the train. If there is only one waiting-room, it should be devoted entirely to women, and the rules of the station should prohibit any smoking, loud talking, or anything that in any way could be a nuisance to the women in it. A much better way, and one that can be followed with very little extra expense, is to have two waiting-rooms—one for women and the other for men. The size of these two waiting-rooms must depend entirely upon the local importance of the station. They should be made as comfortable as an economical expenditure of money will permit.

Opening out of the women's waiting-room there should always be a women's toilet; both waiting-rooms should be supplied, particularly in hot weather, with a liberal supply of good ice-water.

Where the freight and baggage are in one building, there are the following disadvantages: One side of the station must be clear of tracks, or, at least, available for the passage of teams and freight wagons that come to the station to receive or deliver freight. It is also a great advantage to have the side-tracks upon which the freight is loaded or unloaded as near the freight-house as possible; when this freight-house is under the same roof as the passenger station, if the side track runs next to the freight-house, all the passengers must pass to and fro over this side-track in order to reach the main track. This, although not a great source of danger, is usually a great nuisance, particularly in wet weather. On the other hand, if the main track is put next to the platform, in order that the passengers can step directly from the platform upon the train, all the freight from the side track must be moved over the passenger track to get it into the freight-house. This arrangements presents greater disadvantages than the other, for the reason that moving the freight across the main track involves much additional labor, whereas requiring passengers to walk across the side track is merely a slight inconvenience.

All this can be obviated by making the freight-house a separate building, putting it at a sufficient distance of the passenger station and locating it in such a way that the siding can be run in next to it, where it will not only afford accommodations for freight, and where the cars can be so placed that they can be loaded and unloaded directly into and out of the freight-house, but where it will also be entirely out of the way of the passenger traffic.

Plates 26, 27, 28, 29, 30, 31, 32 and 33 give elevations, plans and full details of the standard small station of the Union Pacific Company, which is about the same size as the standard station of the Atchison, Topeka & Sante Fé Railroad, described in Chapter X. The plan and the method of construction adopted in this building will be very readily seen from the drawings.

No bills of material are given with these plans for the same reason as was stated in the preceding chapter—that is, that the dimensions of every piece of timber required are noted on the plans, and also that all the details are given on a larger scale, so that for any particular case it would require very little work for the engineer to make out a proper bill of material.

Moreover, a bill of material which would answer for one particular place would, perhaps for local reasons—such as the kind of timber most easily obtained, cheapest, etc.—not be the best or most economical for another place.

In the two stations of which plans have been given no arrangement is made for living rooms for the agent and his family. When for any reason it is preferred that the agent should live in the station, a somewhat different class of building is required, and a house of this kind will be described and illustrated in a following chapter.

(TO BE CONTINUED.)

MINERAL PRODUCTS OF THE UNITED STATES.

THE sixth report on the Mineral Resources of the United States, by David T. Day, Chief of the Division of Mining Statistics and Technology, United States Geological Survey, is to be issued shortly. This report is for the calendar year 1888, and contains detailed statistics for this period, and also for preceding years, together with much descriptive and technical matter.

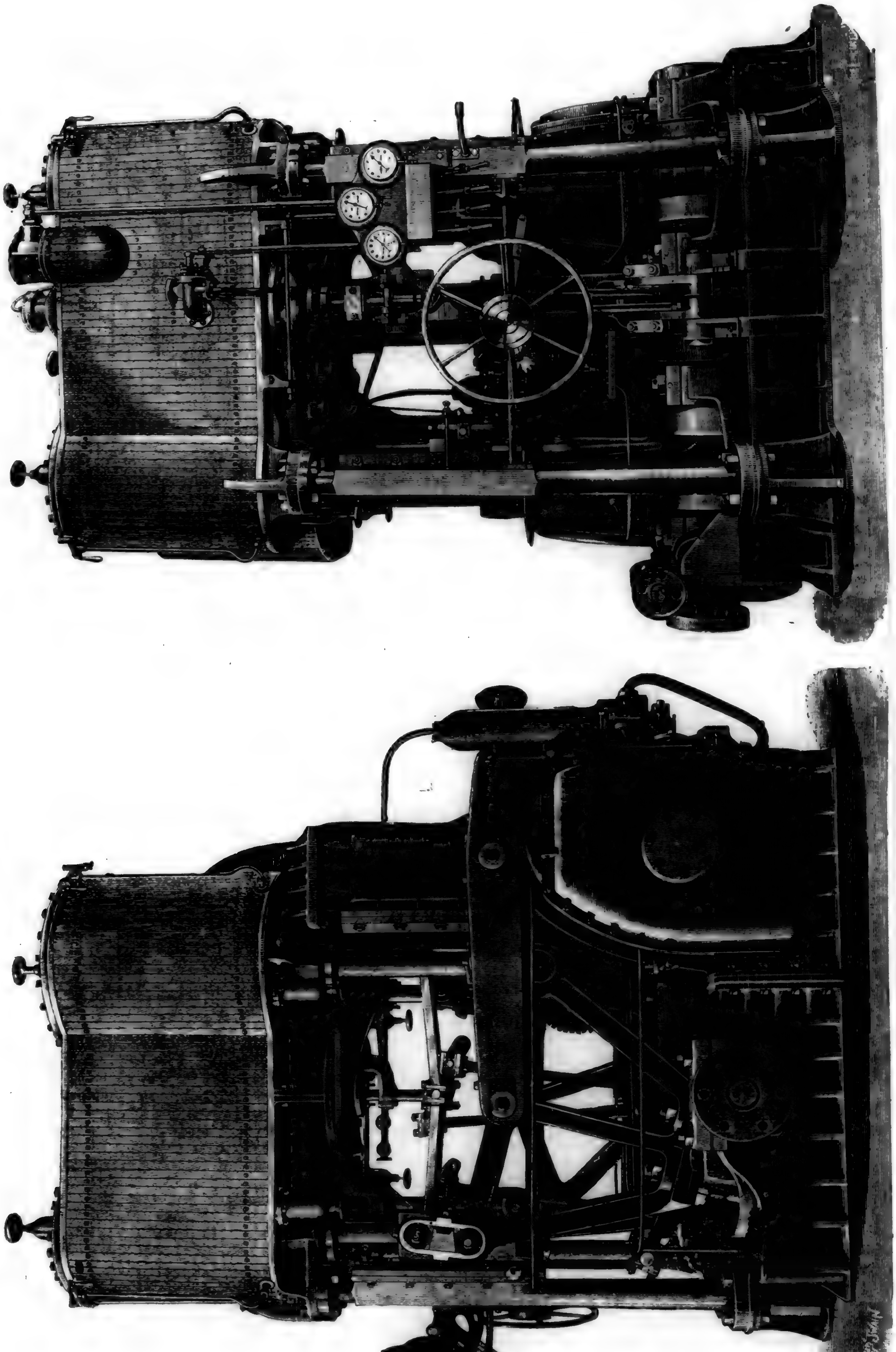
The following table gives in condensed form the total values of the mineral products of the United States for the year:

Metals	$256,245,403
Mineral substances other than metals	328,914,528
Total	$585,159,931
Estimated value of mineral products unspecified	6,500,000
Grand total	$591,659,931

The chief items of the metallic product, taken from the detailed table published in the report, and omitting gold and silver, were: 6,489,738 tons of pig iron, valued at $107,000,000; 231,270,622 lbs. of copper, valued at $33,833,954; 180,555 tons of lead, valued at $15,924,951; 55,903 tons of zinc, valued at $5,500,855.

The principal non-metallic mineral product was, of course, coal, the figures for which, given in the report, make the total output 91,106,998 tons of bituminous, valued at $122,497,341, and 41,624,610 tons of anthracite, valued at $89,020,483; making the total production of coal 132,731,608 tons, with an estimated value of $211,517,824. Other leading mineral products included 49,087,000 barrels of lime, valued at $24,543,500; 27,346,018 barrels of petroleum, valued at $24,598,559; 6,253,295 barrels of cement, valued at $4,533,639; 8,055,881 barrels of salt, valued at $4,377,204; 5,438 tons of limestone, valued at $2,719,000. Building stone is an important mineral product, which cannot well be expressed in any definite quantity or weight, but the estimated value of the stone taken out at the quarry was $25,500,000. Natural gas also cannot be expressed in weight or measure, but the money value of the yield is given at $22,662,128; this estimate is given in coal displacement—that is, the value given is that of the amount of coal which was displaced by the use of natural gas, which is given in the report at 14,163,830 tons. Of this amount 12,543,830 tons were displaced in Pennsylvania, 750,000 tons in Ohio, and 660,000 tons in Indiana.

The summary of the statement given in the introduction of the report is as follows: "The total value of the minerals produced in 1888 was $591,659,931. It is recognized that this is the sum of the values of substances taken in various stages of manufacture, and hence not strictly comparable with each other; still it is the most valuable means for comparing the total products of different years. The result is an increase of nearly $50,000,000 beyond the value of the product in 1887. In that year nearly every mineral industry showed an increase, and hence an increased total was evident. But the fact that the increase was so very large was due to rather exceptional conditions in a few important industries, and it could not reasonably be expected that a similar combination of circumstances would result in even a larger total value for 1888. Nevertheless the unprecedented stimulus given to the production of copper by an artificial price increased the total value of that product nearly $13,000,000, or nearly enough to offset the decline in the total value of pig iron. The other important factors in the increase were coal and the other fuels which followed the increased quantity of metals,



QUADRUPLE-EXPANSION ENGINES, STEAMER "SINGAPORE."

With the anticipated decline of copper to the normal demand, a decline in the total value of the product in 1889 will not be inconsistent with the natural development of our mineral resources."

The value of this series of reports on the mineral resources of the United States, as prepared under the direction of Mr. Day, has increased from year to year with the experience gained by the compilers, and the promptness with which the summary is issued this year adds to its importance and to the benefits which may be derived from it by those interested.

QUADRUPLE-EXPANSION ENGINES, STEAMSHIP "SINGAPORE."

(From the London *Engineer*.)

THE quadruple-expansion engines which have been fitted on board the steamship *Singapore*, and which are shown in the illustrations herewith, are constructed on a new design, which has been patented by the builders, Messrs. Fleming & Ferguson, of Paisley, Scotland. A prominent feature is that two piston-rods lay hold of one triangular connecting-rod, and it will be seen that in consequence there is virtually no dead point. A considerable number of these engines has recently been made by this firm, but those which have been placed in the *Singapore* are the largest quadruples which have yet been turned out, indicating as they do upward of 1,600 H.P. Economy of space and of coal consumption on board our merchant steamers has become the greatest question to be solved, and the solution of the coal consumption part of the question is being solved by the adoption of higher ranges of steam pressure carried to a greater degree of expansion, and the consequent abandonment of compound in favor of triple and quadruple-expansion engines. The advantage gained, however, by this means has been discounted to a certain extent by the fact that such engines have taken up more space on board ship than the compound engines which they displaced, and Messrs. Fleming & Ferguson, in designing the engines, set before them the necessity of economizing space, at the same time that they improved upon the latest practice in triple and quadruple-expansion work. Triple engines, when put upon three cranks, take up considerable fore-and-aft space, and have many working parts, while the quadruple engine, as ordinarily made on the tandem system, has objections which it is not necessary here to enlarge upon, but which weigh very seriously against its general adoption. In common practice it has hitherto been found that the triple is a better and for many reasons more desirable engine than an ordinary quadruple, so that the patentees of the engines have only to establish a superiority in their engine over the best type of triple-expansion engine. They have overcome most, if not all the objections to the quadruple engine, and are at least equal to the three-crank triple in the matter of balance and simplicity of overhaul, while they have to their credit an increased economy of fuel, less ship space, fewer vital working parts to keep up and look after, and a decreased friction on these parts.

As will be seen from the illustrations, the four cylinders are all on the same level, two of them being placed on the port side of the crank shaft and two on the starboard side, all standing vertically, and supported by two cast-iron columns on the condenser and two turned malleable iron columns in front, the four cylinders in this arrangement forming a very compact group. Between the cylinders are two round valve casings, in which piston valves work, there being one valve for Nos. 1 and 2 cylinders, and one valve for Nos. 3 and 4. The covers of the cylinders and valve casings are all independent, and immediately accessible for opening out for examination or overhaul. There is nothing to move before getting at any of the covers, and examination or overhaul can be made in the shortest time. The valve motion is very simple, two eccentrics only being required for either ahead or astern gear for all four cylinders. There are two links—one for each cylinder—one of which is connected directly to the eccentrics by the usual rods, and the other is actuated by the same eccentrics through a pair of bell-crank levers. There are two cranks on the crank-shaft, and these are directly opposite to each other, making the balance of working parts, at least, equal to that of a three-crank engine, while the action of this engine in its working parts is equal to four cylinders placed in line on four cranks at right angles to each other. At the same time the engine is perfectly under control, there being no position of the cranks from which they will not readily start. In the event of an accident to either of the forward pair of cylinders or to the forward crank, which would necessitate the disconnection of that engine, the after engine can be driven as a compound engine, the action of the after pistons on the crank being exactly equal to that of a compound engine with the cranks at right angles, thus obviating the difficulty of starting a single-crank engine. Another advantage of the design is that the weights may be kept very low; and still another that, owing to the breadth of the base which it has, it is perfectly steady when working at a high speed.

At the trial trip of the *Singapore* on the Clyde, the engines gave very great satisfaction to their builders, their owners, and a large party of superintending and other engineers. The steamship *Singapore* has been built by Messrs. Fleming & Ferguson for trading from Singapore to the islands adjacent, and carries 1,500 tons on a draft of 13 ft. She is a long, broad, and shallow vessel, but still a fine model, and pleasing to the eye. She is fitted with accommodation for a limited number of passengers, and has a handsome saloon and comfortable state-rooms. The entire ship is lighted by electricity. She is an exceptionally high-class cargo steamer. The speed over the measured mile in Wemys Bay averaged 12¾ knots, a result considered to be satisfactory by her owners and builders. The engines ran at about 80 revolutions for some hours without a hitch, indicating a little over 1,600 H.P. The cylinders are 24 in., 30 in., 40 in. and 60 in., respectively, in diameter. The stroke of the cylinders is 42 in., while, owing to the angle of the connecting-rod, the stroke of the cranks is 36 in. The connecting-rod is a steel casting of a triangular pattern, each angle of the base taking a piston-rod, while the apex attaches to the crank; the casting is carried beside this by a bar from the center of the base to the side of the back column. The crank and crank-shaft bearings are made very long, and though the engines were quite new, there was nothing of the nature of a hot bearing experienced during the day. The base of the engines is under 10 ft. square, and the total length of the engine-room is about 14 ft. Steam is supplied by a double-ended boiler 14 ft. 6 in. diameter and 18 ft. long, having six furnaces, and working at a pressure of 165 lbs.

The consumption of coal was very low during the trial, but will, of course, be reduced still lower when the vessel has been put into her regular trade. Messrs. Fleming & Ferguson have received a report from another of their ships fitted with similar engines, and which had lately arrived at Buenos Ayres, which report showed the consumption on the outward voyage to have been 112 lbs. per 100 indicated H.P. per hour, a remarkably high result. That this engine is growing in favor cannot be doubted, when it is stated that in the workshops of Messrs. Fleming & Ferguson there are no less than 10 sets in course of construction. The builders claim that these engines may be made suitable for paddle or screw steamers, or for pumping or factory purposes, and in any size for electric lighting. The engines illustrated are the sixth set turned out by the firm, and in every case they appear to have given satisfaction.

THE SPEED OF RAILROAD TRAINS.

IN a paper recently read by M. Banderali before the French Association for the Advancement of Science, on the speed of railroad trains in Europe, the writer gives incidentally the entire length of railroad in Europe at 129,200 miles, of which Germany has 24,600; France, 21,300; Great Britain and Ireland, 19,900; Russia, 17,700, and Austria-Hungary, 15,400 miles, no other country having over 10,000 miles.

The writer says that there are properly three classes of

railroad speed, which are expressed in the distance run per hour ; these are as follows :

1. The *Commercial Speed*, which is obtained by dividing the total distance passed over between two points by the number of hours employed in the transit, without deducting the time taken by stoppages of different kinds. This speed is that which is really the most interesting to the public, and it is this speed which the tendency is to increase continually, chiefly by reducing as much as possible the number of stoppages. This commercial speed varies considerably in different countries according to the circumstances, which include the nature of the traffic, the management, and, in some degree, the national habits. In England, for instance, fast time is considered more than economy, while in Germany the circumstances are exactly reversed.

2. The *Average Running Speed* has a character much narrower and more technical than commercial speed ; this is obtained by dividing the distance between the terminal stations by the actual running time, deducting the time employed in stops. This speed is regulated by a number of circumstances, such as the profile of the line, the weight of trains, the class of locomotives used, the number of junctions, crossings, and other points at which it is necessary to reduce speed, and similar matters.

3. The *Actual Speed* really varies from one minute to another, and can only be accurately measured by some sort of speed-recording machine. This speed is seldom carefully ascertained, and is, indeed, of interest chiefly to the engineer and the master mechanic, who desire to obtain exactly the power developed by the engine, the excellence of the track, the efficiency of the brakes, the good condition of the signals, and many other matters connected with the management.

The table given below compares the commercial and the average running speed (in miles per hour) of several trains on English and French roads and with one German express, to which is added the speed attained by several trains in America. It should be noted that this table does not include the exceptionally high rates of speed attained between London and Edinburgh in the recent contest between the two lines connecting those cities, which has been omitted for the reason that that fast service cannot properly be considered as an average or commercially successful performance, however interesting it may be as a specimen of what can be done upon occasion.

	Distance.	Commercial Speed.	Average Running Speed.
ENGLAND:			
London, Chatham & Dover	77.9	44.5	46.1
London, Brighton & S. Coast	50.3	46.4	47.8
London & Northwestern	159.1	45.4	47.4
Great Northern	188.3	50.1	51.3
FRANCE:			
Northern	183.9	42.9	43.8
Paris-Orleans	363.5	42.3	43.8
Eastern	275.3	40.0	41.8
Paris, Lyons & Mediterranean	536.3	35.1	56.1
GERMANY:			
Berlin-Cologne	365.4	37.6	40.6
UNITED STATES:			
New York-Pittsburgh	444.0	38.6	40.6
New York-Washington	229.2	38.2	40.5
New York-Buffalo	439.0	40.8	41.8
New York-Springfield	136.0	36.3	38.9

The longest runs made without stops in France are on the Northern Railroad, 103.2 miles in 2 hours, 17 minutes, an average of 45.3 miles an hour ; on the Paris, Lyons & Mediterranean Road, 99.4 miles in 2 hours, 38 minutes, an average of 37.3 miles an hour ; on the Orleans Line, 73.8 miles, at an average speed of 44.7 miles per hour ; in England the longest run made without stopping is 105.4 miles in 1 hour, 57 minutes, an average of 53.9 miles an hour ; in Germany the longest run without stops is 83.3 miles in 1 hour, 44 minutes, an average of 47.8 miles an hour ; in Austria the Oriental Express has one run without stop between Buda-Pesth and Szgedin, 118 miles, on an average speed of 37 miles an hour.

To make these long runs without stops, it is necessary to have tenders of large capacity or else to supply the road with track-tanks, from which the water may be taken up while running. The future increase in speed—at least in the commercial speed, which is the most important—must be made rather by omitting stops than by an increase in the actual running time, and this can only be done as increased traffic demands, since the omission of stops implies additional train-service to accommodate the intermediate points between the leading stations where the fast trains stop.

The conclusion drawn is that England is at present clearly ahead in the speed of its trains, a fact which is largely due to the conditions and demands of traffic there ; in Germany and Austria there are only two or three really fast trains, and in France and the United States high speed is confined to a few exceptional trains, a circumstance due to the fact that there does not exist at present a sufficient demand to warrant the expense incurred in running fast trains, since it has been abundantly proved, in both these countries, that the highest grade of speed can be obtained should it be required.

TRANSITION CURVES.

BY CHARLES DAVIS JAMESON, C.E.

(*Concluded from page 272.*)

THE methods of laying out the Transition Curve may be briefly described as follows :

If the curves are put in on the preliminary location of the line, the process will be very simple. First we will consider the case in which the location is made in the field, without the previous use of a paper location. Two methods may be pursued in this case :

1. When the tangent has been located to a point at which it is desired to introduce a curve, drive a plug with a tack point and set the transit over it. Decide which one of the 12 possible parabolas shall be used, being governed in the decision by the radius of the circular curve which is to succeed the transition curve, and also by the configuration of the ground. Having selected the curve most suitable, locate points every 50 ft. by the deflections given in Table I. Having proceeded as far as it is desired on the arc of the cubic parabola, refer to the table bearing the number, in Table I., of the particular parabola selected. Following down the third column until we find the length of transition curve nearest that given, we have in the first column the degree of circular curve which can be introduced at that point ; or the transition curve may be continued until the length opposite any required degree of curvature is reached. In either case the total deflection angle, given opposite that degree of curvature, is turned off and a plug with a tack point is set. Leaving the vernier in that position, the transit is taken up and set over a new point. Reverse the telescope and sight on the point just left. The zeros on the horizontal plate will then be parallel to the original tangent. Clamp the bottom plate, set the verniers to the angle in column 7, and the telescope will then be on a tangent, with the curve at that point. The circular arc can then be run in in the usual manner. To pass from the curve to the tangent is done in a similar manner, except that the intermediate points on the transition curves are located with the transit at the point of tangency. When the circular curve has been extended sufficiently, set the vernier to the angle given in column 7, turn the telescope until it is tangent to the curve, clamp it, loosen the upper plate, and set the vernier to the total deflection angle given in column 6. The telescope will now be directed to the point of tangency, or the junction of the transition curve and tangent. Measure the length

of the transition curve from the tangent. To locate this point of tangency, set up the instrument at this point, direct the telescope to the point just left, clamp, loosen the upper plate, set the vernier to zero. The telescope will

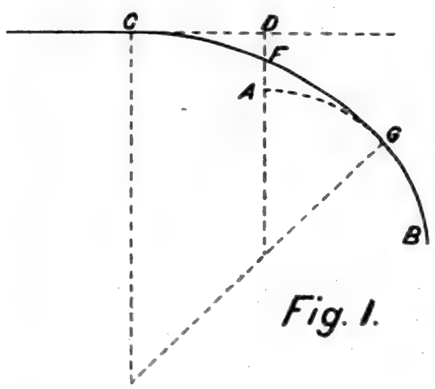


Fig. 1.

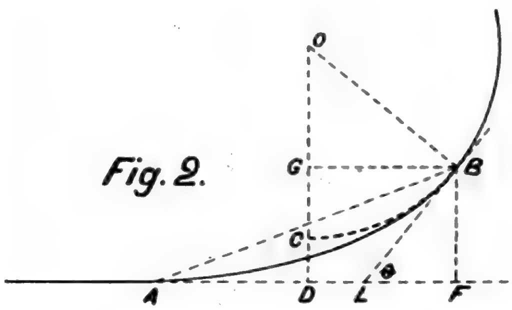


Fig. 2.

now be on the tangent. The intermediate points of the transition curve can now be located, or, if it is desirable, these can be omitted until the final location.

Another method which may be more commonly employed is as follows: When it is desired to introduce a

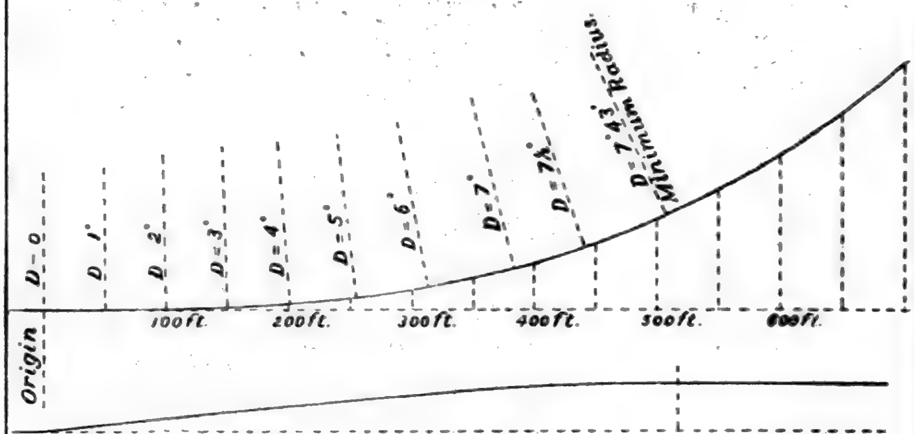


Fig. 7.

curve, run the tangent to the point D, fig. 2. Decide upon the offset and also the degree of circular curve which it is desired to use. Both of these may be varied so as to fit the ground. With the given degree of curve refer to the tables. The desired offset will be found if it is within the limits of the cubic parabolas tabulated. Measure off the offset given in the tables nearest the one desired. Set the transit up on the new point, and turn it parallel to the original tangent by sighting back to some point at an equal distance from the original tangent.

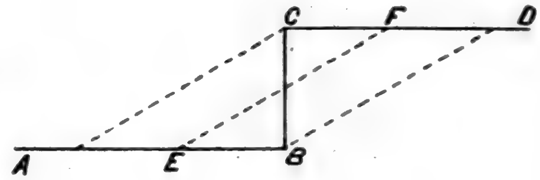


Fig. 5.

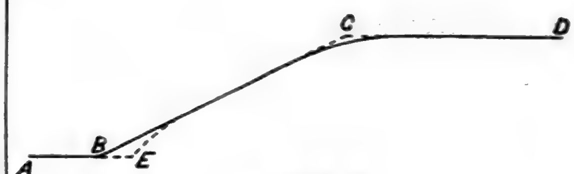


Fig. 6.

The circular curve can now be run in as usual, and the passing from the curve to the next tangent is effected in a similar manner, the offset at the end of the curve being taken of any length that will best suit the contour of the ground, no reference being had to the offset used at the beginning of the curve. The transition curves can then be located at any time by measuring back on the tangent, from the point D, the distance given in column M. Set up the transit at this point, and deflect the angles given in Table I. for that parabola.

When the tangents are already fixed and the central

CURVE No. 1.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.01	18 72	18.72	9.36	0° 5′ 20″	0° 16′ 00″	0 03
3° 30′	0.01	21.85	21.85	10.92	7′ 40″	23′ 00″	0.05
4°	0.02	24.98	24.98	12.49	10′ 00″	30′ 00″	0.07
4° 30′	0.02	28.10	28.10	14.05	12′ 40″	38′ 00″	0.10
5°	0.03	31.22	31.22	15.61	15′ 40″	46′ 50″	0.14
5° 30′	0.05	34.34	34.34	17.17	18′ 50″	56′ 40″	0.19
6°	0 06	37.46	37.46	18.73	22′ 30″	1° 7′ 30″	0.24
6° 30′	0.08	40.59	40.59	20.29	26′ 20″	19′ 10″	0.31
7°	0.09	43.72	43.72	21.86	30′ 40″	31′ 50″	0.37
7° 30′	0.12	46.86	46.86	23.43	35′ 10″	45′ 30″	0.48
8°	0.14	50.00	50.00	24.95	40′ 00″	2° 00′ 10″	0.58
8° 30′	0.17	53.14	53.14	26.50	45′ 10″	15′ 40″	0.70
9°	0.20	56.29	56.29	28.07	50′ 50″	32′ 10″	0.83
9° 30′	0.24	59.47	59.46	29.65	56′ 40″	49′ 50″	0.98
10°	0.28	62.64	62.62	31.21	1° 2′ 50″	3° 8′ 10″	1.14
10° 30′	0.33	65.82	65.80	32.75	9′ 20″	27′ 50″	1.33
11°	0.38	69.04	69.01	34.30	16′ 20″	48′ 30″	1.53
12°	0.50	75.50	75.46	37.43	31′ [illegible]″	4° 33′ 20″	2.00
13°	0.64	82.12	82 05	40.60	47′ 50″	5° 22′ 30″	2.57
14°	0.80	88.86	88.77	43.78	2° 6′ 10″	6° 17′ 10″	3.26
15°	0.99	95.89	95.67	47.05	26′ 30″	7° 17′ 30″	4.08
16°	1.20	102.98	102.82	50.36	49′ 10″	8° 24′ 20″	5.06
17°	1.46	110.53	110.36	53 58	3° 14′ 50″	9° 39′ 40″	6.26
18°	1.77	118.82	118.42	56.93	44′ 20″	11° 5′ 30″	7.74
20°	2.56	138.26	137.40	63.91	5° 1′ 40″	14° 47′ 00″	12.09

CURVE No. 2.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.01	21.41	21.41	10.70	0° 6′ 30″	0° 19′ 20″	0.04
3° 30′	0.01	24.98	24.98	12.49	8′ 40″	26′ 10″	0.06
4°	0.02	28.56	28 56	14.28	11′ 30″	34′ 20″	0.09
4° 30′	0.03	32.13	32.13	16.07	14′ 30″	43′ 20″	0.13
5°	0 05	35.70	35.70	17.85	17′ 50″	53′ 40″	0.19
5° 30′	0.06	39 28	39.28	19.64	21′ 40″	1° 4′ 50″	0.25
6°	0.08	42.86	42.86	21.43	25′ 40″	17′ 10″	0.32
6° 30′	0.10	46.44	46.44	23.22	30′ 10″	30′ 40″	0.41
7°	0.12	50.01	50.01	25.00	35′ 00″	45′ 00″	0.51
7° 30′	0.15	53.60	53.60	26.78	40′ 10″	2° 0′ 40″	0 63
8°	0.19	57.21	57.20	28.56	45′ 50″	17′ 30″	0.76
8° 30′	0.23	60 82	60.81	30.34	51′ 50″	35′ 20″	0.92
9°	0.27	64.44	64.43	32.13	58′ 10″	54′ 20″	1.09
9° 30′	0.32	68.09	68.07	33.93	1° 4′ 50″	3° 14′ 30″	1.29
10°	0.37	71.75	71.73	35.72	12′ 00″	36′ 00″	1.50
10° 30′	0.43	75.43	75.40	37.50	19′ 40″	58′ 30″	1.75
11°	0.50	79 15	79.10	39.32	27′ 40″	4° 22′ 30″	2.02
12°	0.64	86.66	86.60	42.94	45′ 00″	5° 14′ 20″	2.65
13°	0.83	94.34	94.25	46.57	2° 4′ 20″	6° 11′ 50″	3.41
14°	1.02	102.25	102.11	50 22	26′ 00″	7° 15′ 50″	4.34
15°	1.30	110.57	110.35	53.95	50′ 30″	8° 28′ 00″	5.47
16°	1.60	119.41	119.09	57.75	3° 18′ 30″	9° 50′ 10″	6.88
17°	1.98	129.01	128.51	61.64	51′ 00″	11° 24′ 40″	8.65
18°	2.38	139 70	138.97	65.61	4° 30′ 00″	13° 17′ 00″	10.93
20°	3 57	170.14	168.40	74.08	6° 35′ 30″	19° 7′ 10″	19.45

angles known, the methods of laying out the transition curves will be somewhat different.

Let $A\ B$, $B\ C$, fig. 4, be the given tangents, intersecting at B with an external angle Δ. Let $A\ D = d$, the offset at A; $F\ C = d'$, the offset at C. Let $R =$ radius of the circular curve. These may be selected to suit the ground. The tangent distance

$$A\ B = D\ B' + E\ B = R \text{ tang. } \tfrac{1}{2}\Delta + d \cot. \Delta + d' \operatorname{cosec} \Delta,$$

and tangent distance

$$B\ C = R \text{ tang. } \tfrac{1}{2}\Delta + d' \cot. \Delta + d \operatorname{cosec} \Delta.$$

Measure off the tangent distance $A\ B$ from the point

CURVE No. 3.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinates at P.C.C.
3°	0.01	24.99	24.99	12.50	0° 7′ 30″	0° 22′ 30″	0.05
3° 30′	0.02	29.15	29.15	14.57	10′ 10″	30′ 40″	0.08
4°	0.03	33.32	33.32	16.66	13′ 20″	40′ 00″	0.13
4° 30′	0.04	37.48	37.48	18.74	16′ 50″	50′ 30″	0.19
5°	0.06	41.64	41.64	20.82	20′ 50″	1° 02′ 30″	0.25
5° 30′	0.08	45.82	45.82	22.91	25′ 10″	15′ 40″	0.33
6°	0.11	49 99	49.99	24.99	30′ 00″	30′ 00″	0.44
6° 30′	0.14	54.18	54.18	27.08	35′ 20″	45′ 40″	0.55
7°	0.17	58.38	58.38	29.16	41′ 00″	2° 2′ 40″	0.69
7° 30′	0.21	62.58	62.58	31.24	47′ 00″	21′ 00″	0.86
8°	0.26	66.81	66 80	33.33	53′ 30″	40′ 30″	1.04
8° 30′	0.31	71.04	71.03	35.41	1° 00′ 30″	3° 1′ 30″	1.25
9°	0.37	75 31	75.29	37.51	8′ 00″	23′ 50″	1.49
9° 30′	0.44	79.60	79.57	39.61	16′ 00″	47′ 40″	1.76
10°	0 51	83.92	83.87	41.70	24′ 30″	4° 12′ 50″	2.06
10° 30′	0.60	88.26	88.20	43.81	33′ 20″	39′ 30″	2.40
11°	0.69	92.66	92.58	45.92	42′ 50″	5° 7′ 50″	2 77
12°	0.90	101.64	101.54	50.19	2° 03′ 50″	6° 10′ 00″	3 66
13°	1.15	110.94	110.78	54.47	27′ 20″	7° 19′ 30″	4 75
14°	1.42	120.68	120.42	58 82	54′ 00″	8° 38′ 20″	6.10
15°	1.79	131.98	130.59	63.22	3° 24′ 30″	10° 7′ 50″	7.78
16°	2.23	142.19	141.60	67.68	4° 00′ 20″	11° 51′ 50″	9.91
17°	2.77	155.26	154.36	72.37	45′ 30″	14° 1′ 00″	12.84
18°	3.45	171.82	170.30	77.29	5° 47′ 00″	16° 54′ 00″	17 25

CURVE No. 4.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0 02	29.99	29.99	14.99	0° 9′ 00″	0° 27′ 00″	0.08
3° 30′	0.03	34.99	34.99	17.49	12′ 20″	36′ 40″	0.12
4°	0.05	39.99	39 99	19 99	16′ 00″	48′ 00″	0.19
4° 30′	0.06	44 99	44.99	22.49	20′ 20″	1° 00′ 50″	0.26
5°	0.09	50.00	50.00	24.99	25′ 00″	15′ 00″	0.36
5° 30′	0.12	55 02	55.02	27.50	30′ 20″	30′ 50″	0.48
6°	0 16	60.04	60.04	30 00	36′ 00″	48′ 10″	0.63
6° 30′	0 20	65.09	65.08	32.50	42′ 20″	2° 7′ 00″	0.80
7°	0.26	70.13	70.12	35.00	49′ 10″	27′ 30″	1 00
7° 30′	0.31	75.22	75.20	37.51	56′ 30″	49′ 30″	1.24
8°	0.37	80.31	80.29	40.02	1° 4′ 30″	3° 13′ 20″	1.51
8° 30′	0.45	85.44	85.41	42.53	13′ 00″	38′ 40″	1.81
9°	0.54	90.60	90 57	45.05	22′ 00″	4° 5′ 40″	2 16
9° 30′	0.63	95.81	95.77	47.57	31′ 40″	34′ 40″	2.[illegible]6
10°	0.74	101.08	101 03	50.12	42′ 00″	5° 5′ 30″	3.00
10° 30′	0.85	106.44	106.36	52.66	53′ 10″	38′ 20″	3.50
11°	0.99	111.88	111.76	55.22	2° 5′ 00″	6° 13′ 20″	4.06
12°	1.30	123.05	122.86	60.36	30′ 50″	7° 30′ 20″	5.40
13°	1.67	134.80	134.49	65 58	3° 00′ 40″	8° 58′ 20″	7.08
14°	2.14	147.52	147 03	70.89	36′ 00″	10° 41′ 10″	9.25
15°	2.70	161.73	160.95	76.36	4° 18′ 40″	12° 44′ 30″	12.13
16°	3.41	178.27	177.96	82.18	5° 16′ 00″	15° 27′ 10″	16.40
17°	4.38	206.16	203.60	88.46	6° 52′ 40″	19° 53′ 30″	24.56

of intersection. From A measure the offset $A\ D$, and run in the circular curve. The transition curves are then located as before. In case of any obstacle which would prevent the entire location of the transition curve by deflection angles from the starting-point, the curve may be located by offsets from the tangent. These are given for this purpose in the tables.

RAIL ELEVATION.

As has already been stated, the elevation of the outer rail should be proportional to the degree of curvature, or inversely proportional to the radius. When this condition is fulfilled for a certain speed, the train is in perfect equilibrium upon every part of the curve. Since with the cubic parabola the radius of curvature varies nearly in-

CURVE No. 5.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.03	37.49	37.49	18.74	0° 11′ 20″	0° 33′ 50″	0.12
3° 30′	0.05	43.74	43.74	21.87	15′ 20″	46′ 00″	0.19
4°	0.07	50.01	50.01	25.00	20′ 00″	1° 00′ 00″	0.29
4° 30′	0.10	56.25	56.25	28.12	25′ 20″	16′ 00″	0.41
5°	0.14	62.55	62.54	31.26	31′ 20″	33′ 50″	0.57
5° 30′	0.19	68.84	68.83	34.37	37′ 50″	53′ 40″	0.76
6°	0.25	75.15	75.13	37.50	45′ 10″	2° 15′ 30″	0.99
6° 30′	0.31	81.47	81.45	40.63	53′ 00″	39′ 10″	1.26
7°	0.39	87.84	87.81	43.77	1° 1′ 40″	3° 5′ 00″	1.58
7° 30′	0.48	94.24	94.21	46.92	11′ 00″	32′ 50″	1.95
8°	0.58	100.70	100.66	50.08	21′ 00″	4° 2′ 50″	2.37
8° 30′	0.70	107.23	107.17	53.20	31′ 50″	35′ 10″	2.86
9°	0.84	113 84	113.75	56 41	43′ 30″	5° 9′ 50″	3.43
9° 30′	0.99	120.53	120.42	59.59	56′ 00″	47′ 00″	4.06
10°	1.16	127.37	127.22	62.80	2° 9′ 20″	6° 26′ 50″	4 79
10° 30′	1.35	134.36	134.16	66 02	24′ 00″	7° 9′ 50″	5.62
11°	1.56	141.52	141.26	69.26	39′ 30″	56′ 00″	6.56
12°	2.08	156.62	156.20	75.83	3° 15′ 00″	9° 40′ 00″	8.87
13°	2.71	173.37	172.65	82.58	58′ 10″	11° 45′ 30″	11.98
14°	3.53	193.40	192.17	89.69	4° 54′ 40″	14° 27′ 30″	16.52
15°	4.62	222.29	219 85	97.40	6° 25′ 10″	18° 39′ 00″	24.73

CURVE No. 6.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinates at P.C.C.
3°	0.06	50.00	50.00	25.00	0° 15′ 00″	0° 45′ 00″	0.22
3° 30′	0.09	58.35	58.35	29.17	20′ 30″	1° 1′ 20″	0.35
4°	0.13	66.72	66 72	33.35	26′ 40″	20′ 10″	0.52
4° 30′	0.18	75.08	75.08	37.51	33′ 50″	41′ 30″	0.74
5°	0.26	83.49	83.49	41.69	41′ 50″	2° 5′ 20″	1.02
5° 30′	0.34	91.91	91.90	45.86	50′ 40″	32′ 00″	1.35
6°	0.44	100.38	100.36	50.04	1° 00′ 30″	3° 1′ 10″	1.76
6° 30′	0.56	108.93	108.90	54.24	11′ 10″	33′ 10″	2.25
7°	0.70	117.55	117.50	58 44	22′ 50″	4° 8′ 00″	2.83
7° 30′	0.86	126.28	126.20	62.66	35′ 30″	46′ 00″	3.51
8°	1.05	135.15	135.04	66.90	49′ 20″	5° 27′ 20″	4.30
8° 30′	1.27	144.20	144.04	71.17	2° 4′ 20″	6° 12′ 00″	5.22
9°	1.52	153 43	153.22	75.45	20′ 50″	7° 0′ 30″	6.28
9° 30′	1.80	162.99	162.70	79.79	38′ 40″	53′ 30″	7.52
10°	2.12	172.87	172.47	84.14	58′ 20″	8° 51′ 10″	8.95
10° 30′	2.48	183.39	182.85	88.62	3° 20′ 30″	9° 55′ 50″	10.67
11°	2.90	194.42	193.70	93.11	44′ 50″	11° 6′ 50″	12.68
12°	3.92	219.78	218 46	102.41	4° 45′ 40″	14° 2′ 00″	18.20
13°	5.37	257.06	254.21	112.54	6° 26′ 10″	18° 41′ 50″	28.68

versely as the distance from the origin, it follows that the elevation of the outer rail should be proportional to the distance from the same point—that is, at the beginning of the transition curve it is zero, and would increase regularly to its junction with the circular curve.

If the degree of curvature of the transition curve varied exactly as its length, the theoretical profile of the outer rail would be a simple inclined plane, as represented by the dotted line *B C* in fig. 6, where *A B* is the straight track preceding the curve, *B C* the transition curve, and *C D* the circular curve. But, as has already been seen, with the cubic parabola the degree of curvature is not exactly proportional to the distance from the origin. The change becomes less rapid as we approach the point of minimum radius. To correspond with this the profile of the outer rail would be slightly curved near its union with the circular curve, as shown in fig. 7. Instead of joining the level portion at an angle, the profile of the outer rail would be rounded off by a vertical curve of greater or less extent. This is a peculiarity of the cubic parabola, none of the other transition curves giving such a curve to the outer rail. The railroad spiral gives, it is true, a curved

CURVE No. 7.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.08	60.01	60.01	30.00	0° 18′ 00″	0° 54′ 00″	0.31
3° 30′	0.13	70.04	70.04	35.00	24′ 30″	1° 13′ 30″	0 50
4°	0.19	80.09	80 09	40.01	32′ 00″	36′ 10″	0.75
4° 30′	0.27	90.16	90.15	45.01	40′ 40″	2° 1′ 50″	1 07
5°	0.37	100.27	100.26	50.03	50′ 10″	30′ 40″	1.47
5° 30′	0.49	110 45	110.43	55.05	1° 1′ 00″	3° 2′ 50″	1.96
6°	0.63	120.70	120.66	60 09	12′ 50″	38′ 10″	2.55
6° 30′	0.81	131.10	131.03	65.14	25′ 50″	4° 17′ 00″	3.27
7°	1.01	141.64	141.54	70.23	40′ 10″	59′ 40″	4.12
7° 30′	1.25	152.32	152.18	75.31	55′ 50″	5° 46′ 10″	5.13
8°	1.53	163.31	163.10	80.45	2° 13′ 00″	6° 37′ 10″	6.31
8° 30′	1.85	174.64	174.34	85.64	31′ 50″	7° 33′ 20″	7.71
9°	2.22	186.40	185.99	90.87	52′ 50″	8° 35′ 00″	9.36
9° 30′	2.65	198.80	198.23	96.21	3° 16′ 20″	9° 43′ 40″	11.33
10°	3.14	212.03	211.26	101.62	42′ 50″	11° 1′ 10″	13 72
10° 30′	3.71	226.16	225.09	107.04	4° 12′ 50″	12° 28′ 00″	16 59
11°	4.48	242.54	241.03	112.77	49′ 50″	14° 13′ 30″	20.37
12°	6.19	291.65	287.76	125.10	6° 52′ 00″	19° 51′ 50″	34.65

CURVE No. 8.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.12	75.03	75.03	37.49	0° 22′ 30″	1° 7′ 30″	0.49
3° 30′	0.20	87 58	87.58	43.75	30′ 40″	32′ 00″	0.78
4°	0.29	100.18	100.18	50.03	40′ 10″	2° 00′ 20″	1.17
4° 30′	0.31	112.81	112.80	56.29	50′ 50″	32′ 40″	1.67
5°	0.57	125.56	125.53	62.57	1° 3′ 00″	3° 9′ 00″	2.30
5° 30′	0.76	138.44	138.38	68.88	16′ 30″	49′ 30″	3.08
6°	0 99	151.45	151.36	75.20	33′ 50″	4° 34′ 20″	4.03
6° 30′	1.27	164.74	164 61	81.56	48′ 20″	5° 24′ 10″	5.19
7°	1.60	178.30	178.10	87.97	2° 6′ 50″	6° 19′ 10″	6 57
7° 30′	1.98	192.33	192.03	94.42	27′ 30″	7° 20′ 10″	8 24
8°	2.43	206.91	206 47	100 94	50′ 20″	8° 27′ 50″	10.24
8° 30′	2.96	222.41	221.78	107.62	3° 16′ 30″	9° 44′ 33″	12.69
9°	3.48	238.98	238.07	114.37	46′ 20″	11° 11′ 30″	15.70
9° 30′	4.31	257.38	256.08	121.33	4° 21′ 50″	12° 53′ 40″	19.54
10°	5.20	278 96	277.02	128.57	5° 6′ 10″	14° 59′ 50″	24.73
10° 30′	6.30	307.19	304 09	136.20	6° 8′ 30″	17° 53′ 30″	32.72

CURVE No. 9.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.22	100.09	100.09	50.00	0° 30′ 00″	1° 30′ 10″	0.87
3° 30′	0.35	116.89	116.88	58.35	41′ 00″	2° 2′ 50″	1.39
4°	0.52	133.80	133.78	66.74	53′ 40″	41′ 00″	2.09
4° 30′	0.74	150.79	150.75	75.10	1° 8′ 10″	3° 24′ 20″	2.99
5°	1.02	168.07	167.99	83.54	24′ 40″	4° 13′ 30″	4.14
5° 30′	1.37	185.65	185.52	92.01	43′ 10″	5° 9′ 00″	5.57
6°	1.79	203.64	203.42	100.52	2° 4′ 00″	6° 11′ 00″	7.35
6° 30′	2.30	222.33	221.98	109.14	27′ 40″	7° 21′ 00″	9.55
7°	2 91	241.83	241.30	117.85	54′ 30″	8° 40′ 00″	12.26
7° 30′	3.64	262.92	262.10	126.81	3° 25′ 50″	10° 11′ 50″	15.71
8°	4.52	285.84	284.60	135.90	4° 2′ 40″	11° 58′ 20″	20.12
8° 30′	6.07	312.33	310.40	145.33	48′ 20″	14° 9′ 30″	26.10
9°	6.98	346.41	343.20	155.28	5° 52′ 10″	17° 8′ 20″	35.28

outer rail profile, but, as will be seen from *E C*, fig. 6, the curve is an objection rather than an advantage.

The method of adjusting the outer rail on a transition curve composed of cubic parabolas is very simple. After calculating in the usual manner the proper elevation to

CURVE NO. 10.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tan-gent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordi-nate at P.C.C.
3°	0.49	150.3	150.3	75.0	0° 45′ 10″	2° 15′ 30″	1.97
3° 30′	0.78	175.7	175.7	87.6	1° 3′ 10″	3° 5′ 00″	3.15
4°	1.18	201.6	201.5	100.2	21′ 10″	4° 3′ 10″	4.76
4° 30′	1.69	227.9	227.7	112.9	43′ 40″	5° 10′ 10″	6.87
5°	2.34	255 0	254.7	125.7	2° 9′ 40″	6° 27′ 30″	9.61
5° 30′	3.15	283.5	283.0	138 7	40′ 00″	7° 57′ 30″	13.19
6°	4.18	314.0	313.1	151.9	3° 15′ 50″	9° 42′ 30″	17.86
6° 30′	5.46	347.9	346.4	165.6	59′ 40″	11° 49′ 40″	24.18
7°	7.11	388.2	385.6	179.8	4° 56′ 40″	14° 32′ 50″	33.36
7° 30′	9.33	447 0	441.9	195.3	6° 29′ 00″	18° 49′ 10″	50.20

CURVE NO. 11.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tan-gent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordi-nate at P.C.C.
3°	0.88	200 7	200.7	100.1	1° 00′ 30″	3° 1′ 00″	3.53
3° 30′	1.40	235.2	235.1	116.9	22′ 50″	4° 8′ 22″	5.67
4°	2.12	270.4	270.2	133.9	52′ 02″	5° 27′ 30″	8.61
4° 30′	3.05	307.0	306.6	151.0	2° 21′ 00″	7° 00′ 50″	12.58
5°	4.25	346.1	345.3	168.4	58′ 40″	8° 52′ 20″	17 97
5° 30′	5.82	389.6	388 1	186.5	3° 45′ 40″	11° 9′ 10″	25.50
6°	7.90	441.1	438 4	205.3	4° 47′ 40″	14° 7′ 10″	36.77
6° 30′	10.81	517.2	511.2	225.7	6° 30′ 20″	18° 53′ 10″	58.29

CURVE NO. 12.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tan-gent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordi-nate at P.C.C.
3°	2.02	303.0	302.8	150 4	1° 31′ 40″	4° 34′ 30″	8.08
3° 30′	3 20	356.7	356.3	175.9	2° 6′ 50″	6° 19′ 20″	13.16
4°	4.89	414.1	413.2	202.0	50′ 40″	8° 28′ 30″	20.52
4° 30′	7.19	478.5	476.7	229.0	3° 47′ 00″	11° 13′ 00″	31.51
5°	10.43	559.0	555.0	257.5	5° 7′ 10″	15° 2′ 50″	49 73

the rails on the circular curve, mark a point on the transition curve 5, 10, 20, or more feet from its juncture with the circular curve, depending upon the length of the transition curve, beginning at the point of curve to elevate the rail, so that if continued it would obtain its full elevation at the point marked. But before that point is reached, begin to introduce the vertical curve and obtain the full elevation at the beginning of the circular curve.

Fig. 7 shows the cubic parabola, No. 10 of the table, plotted to a scale of 100 ft. to the inch. At the origin the radius of curvature is infinity, and the degree of curvature zero. From this point the degree of curvature begins to increase at the rate of one degree for every 50 ft. This rate of increase begins to decrease perceptibly after the first 200 ft., so that near the point marked minimum radius the rate is scarcely one degree in 100 ft. After passing the point of the minimum radius, the radius begins to increase until, finally, it becomes infinite at an infinite distance.

In the lower part of the figure is shown the corresponding profile of the outer rail. The horizontal scale is 100 ft. to the inch, and the vertical scale 20 ft. to the inch, in order to render the elevation more apparent.

In the table giving the deflection angles and offsets for locating the intermediate points on transition curves, the 50-ft. chords for the deflection angles are, of course, meas-

DEFLECTION ANGLES AND OFFSETS FOR LOCATING INTERMEDIATE POINTS ON TRANSITION CURVES.

	Curve No. 1.		Curve No. 2.		Curve No. 3.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	40′ 00″	0.58	35′ 00″	0.51	30′ 00″	0.44
100	2° 39′ 40″	4.66	2° 19′ 50″	4.07	2° 00′ 00″	3 49
150			5° 10′ 00″	13.75	4° 26′ 50″	11.79

	Curve No. 4.		Curve No. 5.		Curve No. 6.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	25′ 00″	0 36	20′ 00″	0.29	15′ 00″	0.22
100	1° 40′ 00″	2.91	1° 20′ 00″	2.33	1° 00′ 00″	1 75
150	3° 43′ 10″	9.81	2° 59′ 00″	7.85	2° 14′ 30″	5.89
200			5° 14′ 30″	18.62	3° 57′ 40″	13.96

	Curve No. 7.		Curve No. 8.		Curve No. 9.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	12′ 30″	0.18	10′ 00″	0.15	7′ 30″	0.11
100	50′ 00″	1.45	40′ 00″	1.16	30′ 00″	0.87
150	1° 52′ 20″	4.91	1° 30′ 00″	3.93	1° 7′ 30″	2.95
200	3° 18′ 40″	11.64	2° 39′ 20″	9 31	1° 59′ 40″	6.98
250	5° 7′ 10″	22.73	4° 7′ 10″	18.18	3° 5′ 00″	13.64
300					4° 26′ 40″	23.56

	Curve No. 10.		Curve No. 11.		Curve No. 12.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	5′ 00″	0.07	3′ 45″	0.05	2′ 30″	0.04
100	20′ 00″	0.58	15′ 00″	0.44	10′ 00″	0.29
150	45′ 00″	1.96	33′ 45″	1.47	22′ 30″	0.98
200	1° 19′ 50″	4.65	1° 00′ 00″	3 49	40′ 00″	2.33
250	2° 4′ 40″	9.09	1° 33′ 40″	6.82	1° 2′ 30″	4.55
300	2° 59′ 00″	15.71	2° 14′ 30″	11.78	1° 30′ 00″	7.85
350	4° 2′ 20″	24.94	3° 2′ 40″	18.71	2° 2′ 10″	12.47
400	5° 14′ 10″	37.23	3° 57′ 30″	27.93	2° 39′ 20″	18.62
450			4° 58′ 50″	39.76	3° 21′ 00″	26.51
500					4° 7′ 20″	36.36

ured along the curve, while the distances for the offsets are measured along the original tangent.

The following formulas can be applied to the foregoing transition curves with approximate accuracy. As will be seen by comparing results given by them with the tables, they are correct when only a very small offset is taken, but as the offset increases, the error also increases.

They will undoubtedly be of value to the field engineer upon location, as they can be memorized, and thus avoid the necessity of carrying the tables into the field when only the circular curves are to be run with the offsets, but the transition curves not run in until the final location.

The approximate total length of the transition curve can be obtained at once, and its approximate position on the ground. In this manner they may be of some use, but for the accurate running in of the curves the tables should be used.

$$l = 1000 \frac{D}{a}$$

$$a = \sqrt{\frac{D^3}{10.1367\, d}}$$

$$\theta = 37.2 \sqrt{d\, D}$$

$$l = 370 \sqrt{\frac{d}{D}}$$

$\theta =$ Total deflection angle in minutes.
$a =$ Deflection at first 100 ft. in minutes.
$d =$ Total offset in feet.
$D =$ Degree of circular curve.
$l =$ Total length of transition curve in feet.

From this we see that the length of the transition curve varies approximately as the square root of the offset, and for a given offset inversely as the degree of curve.

RELINING A TUNNEL IN USE.

[Note by M. G. Liebeaux, Chief Engineer of the Orleans Railroad, in the *Revue Generale des Chemins de Fer.*]

THE Saulzaie Tunnel, on the Angers-Nantes line of the Orleans Railroad, is near the station of Clermont-sur-Loire, and is 85 meters (279 ft.) in length.

It was cut through an old formation of mica-schist, having the form of schistous masses, the strata sharply inclined toward the foot of the hill and separated by thin veins of clay, proceeding from the decomposition of the mica, and cut in different directions by cracks or fissures.

When the tunnel was built, the engineers, struck by the hardness of the rock, supposed that the mass was homogeneous, and concluded—wrongly, as the result shows—that lining was not necessary. They simply built at each end a portal or arch extending 7 meters into the tunnel.

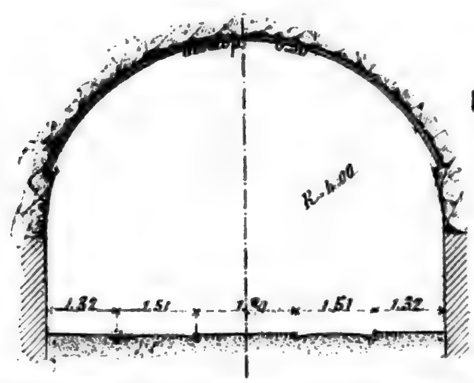


Fig. 1.

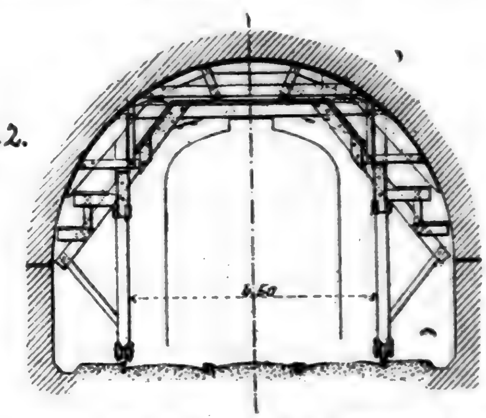


Fig. 2.

Under the influence of air and moisture disintegration began. Water also, working through the fissures, acted on the clay veins, and soon the fall of schistous masses, more or less considerable in size, was noted.

In 1866 a plan was prepared for building a complete lining 0.11 meter thick, but it was never carried out.

About 1880 new falls of rock from the roof began. A little masonry was put in and special service for watching the tunnel was arranged. A day-watchman and later a night-watchman were stationed permanently at the tunnel.

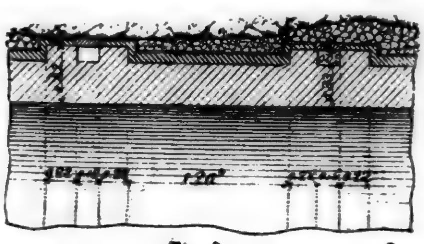


Fig. 3.

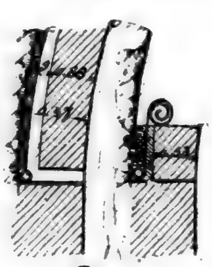


Fig. 4.

Their duty was to pass through the tunnel just before each train was due, and to give the signal to stop, in case of a fall of rock.

The cost of this was considerable, the salaries of the two watchmen amounting to 2,400 francs a year. Safety was guaranteed, but damage to the tunnel was not prevented, and the arrangement was evidently only a temporary postponement of the problem, not a proper solution.

Evidently it would be better to use all or part of the capital corresponding to the yearly cost of watching the tunnel in the execution of permanent works which would make the tunnel safe and do away with the necessity of special care.

The best solution would have been the complete lining of the tunnel with masonry; unfortunately the conditions were such and the expense so great as to raise serious objections to this.

The plan proposed in 1866 was more theoretical than practical. It proposed the construction of a circular arch 4 meters radius and 8.50 meters development. The rock was to be cut out to receive the arch.

The difficulty laid precisely in this cutting out. In a compact rock unchangeable when exposed to air, the operation would have been costly but simple, but in the Saulzaie Tunnel it was not possible, on account of the inclination of the strata and the nature of the rock itself. Several trials made for this special purpose proved that it would be entirely impossible to make recesses which would give any regular bearing surface, and a complete arch would be necessary.

The Saulzaie Tunnel has not the full standard size, being only 7.40 meters in width instead of 8.00 meters, which is the size adopted for double-track tunnels. It was thus impossible to reduce the size any further, by building supporting walls to sustain the arch, and it was necessary to use the existing supports or to cut out the rock in a way which had not been foreseen in 1866.

The expense and the work of a complete relining thus took on new importance. In 1866 the expense, it was thought, would not be over 11,000 francs, but later it was found that a correct estimate would be fully five times that amount.

Fortunately a careful examination of the tunnel, with soundings and borings in the rock, revealed the fact that a complete relining would not be necessary, and that there were really only two dangerous sections, one 6 meters in length at the eastern end of the tunnel, and the other 8 meters long at a point 22 meters from the western portal. In these sections there were many cracks, deep holes, and a marked crumbling of the rock.

The construction, not of an arch 0.11 meter thickness, but of two heavier rings solidly founded, seemed to be sufficient to meet and remedy the evil. This expectation has been realized. The work has been completed for some time and there has been no further trouble with the tunnel.

Owing to the space required for the work, it was necessary to suspend the use of the double track while it was going on, and a temporary track was laid through the center of the tunnel for the use of trains. The cutting out of the rock was done in short sections of about 1.20 meters each, and the masonry followed up as closely as possible the taking out of the stone. The work had to be done with a pick, because blasting would have caused further crumbling of the rock and occasion serious accidents.

To support the working stage and the centers for the arches there was used a wooden scaffolding resting upon wheels, which traveled on the outer rails of the two tracks temporarily abandoned; this scaffolding is shown in fig. 2. The free space above the stage was only 0.60 meter in height, and the masons could only work on their knees. Water worked through in quantities; it was carried off by movable gutters, but in spite of all precautions taken caused

much trouble to the workmen, who for some time had to adopt a waterproof dress.

The arch was built of brick and was for the most part 0.33 meter in thickness, but at some points where the water came through in large quantities it was increased to 0.44 meter, and there were made drains 0.16 meter diameter, as shown in fig. 3. The arch was covered by a cope 0.05 meter in thickness and by a layer of tarred felt, which was unrolled as the masonry was built up, as shown in fig. 4. The gap between this felt and the rock was filled in with stones worked in by hand.

In consequence of the very limited space, in which only a few men could work at a time, a little over five months was occupied in the work, and during that time a single track only, as noted above, was used through the tunnel. The train service was arranged by special order, home and distant signals being placed at each end of the tunnel, under the control of a special signal officer, and no accident whatever took place.

The work was done by contract, and cost in all 10,802 francs, or about 770 francs per running meter ($136 per yard); that is to say, very nearly as much as the cost per meter of a new tunnel.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page* 259.)

Part II. Gun Construction in the United States.

I.—Material.

The fabrication of high-power ordnance in the United States is yet in its infancy. The small progress already made has only been reached through a long travail of experiment—experiment carried on in the persistent belief that cast iron was to be the cannon metal of the future. As in France, where they spent 120 years and wasted millions in the vain endeavor to get first-class work from a third-rate metal, we, for about the same period, followed in much the same lines; and that we have not wasted an equal number of millions is due more to the parsimony of Congress than to any want of willingness on the part of our gun-makers.

It is, of course, impossible to say how much of this persistent advocacy of cast iron, either alone or in combination with steel, is due to the influence of ordnance officers of the Army and Navy, and how much to outside pressure exerted upon Congress by the iron interests of the country. That it has had a strong following is well known, and that it still has earnest advocates is shown by the fact that we now have, for the land service, completed, undergoing construction or awaiting trial, one 12-in. cast-iron breech-loading rifle; a 12-in. cast-iron breech-loading rifle, hooped and tubed with steel; one of the same character lined with a steel tube, and a 10-in. cast-iron breech-loader, wrapped with wire.

That it would have been impossible 20 years ago to have procured in the United States steel forgings for even a gun of small caliber goes without the saying, and the same might be said up to five or six years ago; but there never was a good reason why, during this time, we should not have gone into the steel markets of Europe and bought rough forgings, as in the end we had to do, in order to make a beginning at gun construction.

II.—Army Ordnance.

During the war and the years immediately following its close—that is, up to 1870, there were made in the United States, in addition to the Parrott guns already referred to, three 8-in., one 10-in. and three 12-in. cast-iron, muzzle-loading rifles. These guns were cast at the South Boston and Fort Pitt foundries upon the Rodman principle of interior cooling, and were expected to show that American cast iron, properly manipulated, could be made to do duty in rifled as well as smooth-bore ordnance. They were, with two exceptions, subsequently all fired to extremity, with charges of only about one-tenth of the weight of the projectile. The fact that one of these guns was fired over 1,000 rounds, while another burst at the 27th, another at the 70th, and another at the 80th round, indicates the unreliability of the metal.

Beginning with 1870, the United States may be said to have been entirely destitute of heavy rifled ordnance. The Parrott rifles mounted in our sea-coast works were looked upon with more than suspicion, and nothing had yet been done looking to the rearmament of our forts and ships. Our dependence at this time was entirely upon smooth-bore guns—8, 10, 13, 15 and 20-in. Rodman, in the land service, and 9, 11 and 15-in. shell-guns (Dahlgren) in the Navy. Without the knowledge or facilities for the manufacture of steel in large masses suitable for gun construction, and, one might add, without the inclination to secure it abroad, recourse was had perforce to two methods—either a return to further experiments with cast iron pure and simple, or to a combination of cast iron strengthened with some other metal.

III.—Cast-Iron Guns.

The appropriation bill of 1880 provided for the construction of four 12-in. cast-iron breech-loading rifles. Awaiting the action of the Getty Board on Heavy Ordnance, appointed the following year, the construction of these guns was postponed. Under the Act of 1883 one cast-iron breech-loader was authorized, together with those previously mentioned, to be made of cast iron reinforced with steel—one with a steel tube, another with a steel tube and hooks, and a third wire-wound. A wire-wound 10-in. steel gun was also authorized by the same Act. The contract for the casting of this gun, together with that of the bodies of the other iron guns authorized, was given to the South Boston Iron Works.

Of the 12-in. cast-iron gun, hooped and tubed with steel, just alluded to, and now under construction, much is expected by the advocates of composite guns. Fig. 1 shows the details of construction.

The 12-in. cast-iron rifle was finished in 1885, and turned over to the Ordnance Department for trial. In all 137 rounds have been fired from this piece, with a 265-lbs. charge of powder, and a projectile of 750 lbs. A velocity of 1,750 feet-seconds was obtained. At the end of the 137th round the bore was found to be so much eroded that further trial was considered unsafe, and the piece was withdrawn.

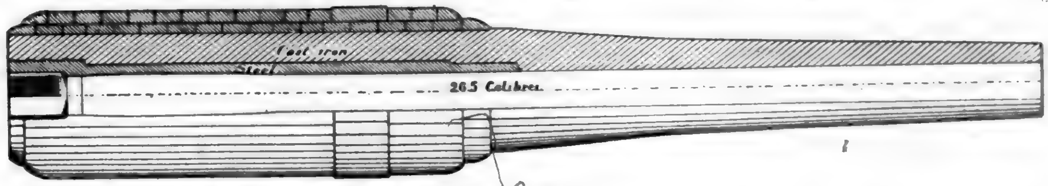
IV.—Converted Guns.

With the large number of cast-iron guns on hand, principles of economy here, as they had in France and Italy, led to the attempt to convert them into efficient rifles. It must be confessed that the results obtained were decidedly more satisfactory than abroad. Still the ballistic qualities of the converted guns were far below what we now have a right to expect of a rifle. The guns so converted were, however, a great improvement upon existing ordnance. The most that can be said against the system is that it undoubtedly delayed for nearly 10 years the development of the modern high-power gun.

The plan as originally proposed was to convert our 10, 13 and 15-in. smooth-bore Rodman guns into 8, 10 and 11-in. rifles by reboring and inserting a rifled wrought-iron tube of the required caliber. Experimental pieces of 8 and 9-in. caliber were first made, and these were followed by those of 10 and 11 in. Insertion of the tube from both the muzzle and breech was also experimented with. In the muzzle insertion the tube was held in place by a steel muzzle collar screwed into the casing or cast-iron body of the gun. With the breech insertion the piece was bored through its entire length, the tube inserted from the rear, and the breech closed by a steel breech plug. Corresponding shoulders upon the tube and casing gave longitudinal strength to the gun. As the result of these experiments the 8-in. gun was the only one recommended for service. Up to 1878 these guns were converted by insertion of the tube from the muzzle. But it was found that the coiled wrought-iron tube received insufficient support against

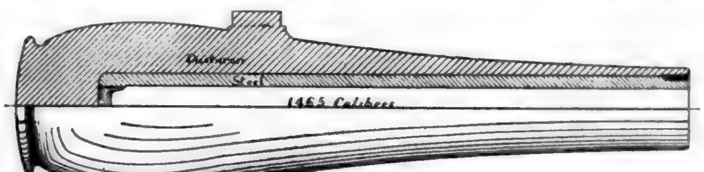
longitudinal stress from the muzzle collar alone. From this time up to 1884 breech insertion was employed; the tube, as before, being of coiled wrought iron. At the latter date steel tubes were substituted for those of wrought iron, and muzzle insertion again resorted to. In both systems of insertion a slight play was allowed between the tube and the body of the gun.

The conversion of these guns ceased in the following year—a total of something over 200 having been converted. The method of conversion is shown in fig. 2.



12-inch, 34-ton Army B.L. Rifle. Fig. 1.

Breech-loading pieces of 8 and 11-in. calibers were also constructed—13 and 15-in. Rodman guns supplying the shells. The tubes were of wrought iron, steel-jacketed, with the jacket prolonged sufficiently to the rear to receive the breech mechanism, which was of the wedge or Krupp pattern. These pieces were chambered to receive a considerably increased charge of powder. The steel forgings were procured in England. The first 8-in. gun stood a successful test of more than 600 rounds The test of an 8 in. and an 11 in. which followed (October, 1881) was not so satisfactory. The 8-in. gun burst at the 127th round, the 11 in. at the 18th. The failure of these guns had for the time being a disastrous effect both upon the use of steel in gun fabrication and upon all breech-loading guns in general, and Krupp's system in particular, although the failure in both cases was shown to have been owing to a wretched quality of steel, on the one hand, and to faulty details of construction on the other. It gave, however, an additional lease of life to cast iron.



8-Inch converted Rifle Fig. 2.

An 11-in. muzzle-loading chambered rifle was also constructed by conversion, in which both the tube and its jacket were of wrought iron. None of the calibers of converted guns mentioned can be considered as more than experimental, except the 8 in., which has become a service type. A number of converted breech-loaders of this caliber were also finished, and form a part of our available armament.

8-inch 13½ ton Army B.L. Rifle. Fig. 3

V.—BUILT-UP GUNS.

Under Act of Congress of March 3, 1881, a Board on Heavy Ordnance and Projectiles, known as the Getty Board, was appointed to examine and report upon all plans for the fabrication of heavy guns and projectiles that might be submitted to it. The report of this Board was submitted the following year. It was decidedly non-committal in tone, and among a number of devices for gun construction recommended for trial, we find a half-hearted recommendation for an all-steel, built-up gun. The Senate Ordnance Committee of 1883, acting upon the recommendations of the Getty Board, among other things, approved of this recommendation, and the Act of that year authorized the construction of the first steel built-up breech-loading rifle.

The first essay was with a gun of 8-in. caliber. The forgings for the tube and jacket were ordered from Whitworth, the hoops from the Midvale Steel Works. This piece was assembled and finished at the West Point Foundry, and turned over for trial in 1886.

As originally constructed, the chase of this gun was only partly hooped. After firing some 20 odd rounds evidences of weakness appeared, and it was returned to the shop and the chase hooping extended to the muzzle. All future constructions are to have the chase hooped throughout. This may be considered a type gun, and the general methods of construction will undoubtedly be followed in the larger calibers. Fig. 3 shows the manner in which it is built up.

A 10-in. rifle of the same general design is now under construction, and is likely to be finished during the present year. The tube, jacket and trunnion-hoop come from Whitworth, the hoops from the Cambria Iron Works.

In addition to these guns, a 12-in., 45-ton, and a 16-in., 115-ton steel breech-loaders have been designed for the Army.*

VI.—CAST-STEEL GUNS.

In March, 1887, Congress appropriated some $20,000 for the purchase of three rough-bored and turned cast-steel 6-in. guns, one to be of Bessemer, one of open-hearth, and one of crucible steel; the guns to be finished at the Washington Navy Yard, and tested at the Naval proving-ground. The Pittsburgh Steel-Casting Company supplied a Bessemer casting, and the Standard Steel-Casting Company, of Thurlow, Pa., one of open-hearth steel, under this appropriation. No proposals for a crucible-steel gun were received.

With regard to these guns, it was specified that they should be composed of steel of domestic manufacture, made from the best quality of raw material, each to be of one piece, except the breech-plug—and the trunnion-band if desired—and to be unforged.

In their proposals both bidders promised, as regards test specimens, a tensile strength of 80,000 lbs. per square inch, an elastic limit of 40,000 lbs., and a finished weight of 11,000 and 12,000 lbs. for the Pittsburgh and Thurlow guns respectively.

As the result of the tests made at the Washington Navy Yard, eight in number for each gun, specimens taken from both breech and muzzle, we find the average tensile strength shown by all the tests to be 80,293 lbs. for the Pittsburgh and 80,322 lbs. for the Thurlow gun, with corresponding elastic limits of 49,269 and 38,024 lbs. per square inch.

* The difference between a high-power gun and one of the old pattern cannot be better shown than by comparing our Army 8-in., 13½-ton breech-loading steel rifle with the converted guns of the same caliber of 8 tons weight. The data of the converted gun are as follows: Charge, 27 lbs.; shot, 183 lbs.; initial velocity, 1,200 feet-seconds; pressure, 2,700 lbs. per square inch; muzzle energy, 1,871 foot-tons. The built-up rifle: Charge, 110 lbs.; shot, 300 lbs.; initial velocity, 1,860 feet-seconds; pressure, 3,580 lbs.; muzzle energy, 7,195 foot-tons. The 7,000 against the 1,800 foot-tons of energy tells the story.

The statutory proof of these guns was to be 10 rounds fired as rapidly as possible, with full service charge of 48½ lbs. and a projectile of 100 lbs., and an initial velocity of 2,000 feet-seconds.

The Bessemer gun was tested on December 5 of last year. A preliminary round with reduced charge was fired to set the gas-check. The piece was then loaded with the full charge of 48½ lbs. of powder and a 100-lbs. shell. The gun burst, breaking up into many fragments. So far as could be discovered at the time, no special defects in the metal were apparent. The three pressure-plugs, recovered after the explosion, gave an average pressure of 31,623 lbs.

The Thurlow gun was tested on February 7 last. Two preliminary and the 10 required rounds with full charges were fired. The gun stood the test. Certain erosions in the bore in front of the seat of the projectile would seem to indicate that when fired for endurance it might not give so good an account of itself. The estimated pressure was 15 tons per square inch.

In the Act of Congress approved in September last, we find the first decided step looking toward the construction of a permanent system of ordnance for the Army. Under its provisions a board of four officers, with the Commanding General of the Army at its head, and known as the Board of Ordnance and Fortifications, was appointed to supervise and direct the very liberal appropriations made by the Act.

First, we find an appropriation of $700,000 for the necessary structures, machinery, and tools for an Army Gun Factory, for finishing and assembling heavy ordnance, to be erected at the Watervliet Arsenal, West Troy, N. Y. Following this, $500,000 is appropriated for the completion of guns under fabrication, and for the tests of guns and carriages; $1,500,000 is set aside for the purchase of rough-finished, oil-tempered, and annealed steel for high-power coast-defense guns, of 8, 10, and 12-in. caliber; $250,000 for 12-in. breech-loading mortars, cast iron hooped with steel; and, finally, an appropriation of $6,000,000, to be expended at a rate not exceeding $2,000,000 a year, for the purchase of breech-loading steel guns of 10 and 12-in. caliber from private parties, such guns to be of a weight and dimensions prescribed by the Board, and to be tested by the same.

Here we find a new departure from the methods heretofore followed. Every gun-maker in the country has now a chance of finding a market for his wares, provided they come up to the required standard. The requirements for these guns, as formulated by the Board, are interesting, and indicate how great has been the advance in the matter of accuracy, range, and endurance of heavy guns within the last decade.

For the 10-in. gun it is to be about 30 tons in weight; 34 calibers length of bore; possess a muzzle energy of not less than 15,000 foot-tons; a range at 20° elevation of about eight miles; pass an endurance test of 300 rounds with full charges, and, as to accuracy, be able to put 25 per cent. of its shots within a vertical rectangle, 1.4 ft. by 1 ft., at 1,500 yards range, and within a horizontal rectangle, 48.5 yards by 9.2 yards at 10,000 yards range. The projectile is to weigh 575 lbs., and a rapidity of fire of 15 shots per hour be attainable.

The 12-in. gun is to have a weight of about 52 tons; a length of bore of 34 calibers; a muzzle energy of 26,000 foot-tons; a range of about 8½ miles at 20° elevation; the accuracy to be the same as that given for the 10-in. gun, and it must pass an endurance test of 250 rounds with full charges. The projectile is to have a weight of about 1,000 lbs., and the gun be able to fire at least 10 shots per hour.

(TO BE CONTINUED.)

Fig. 158.

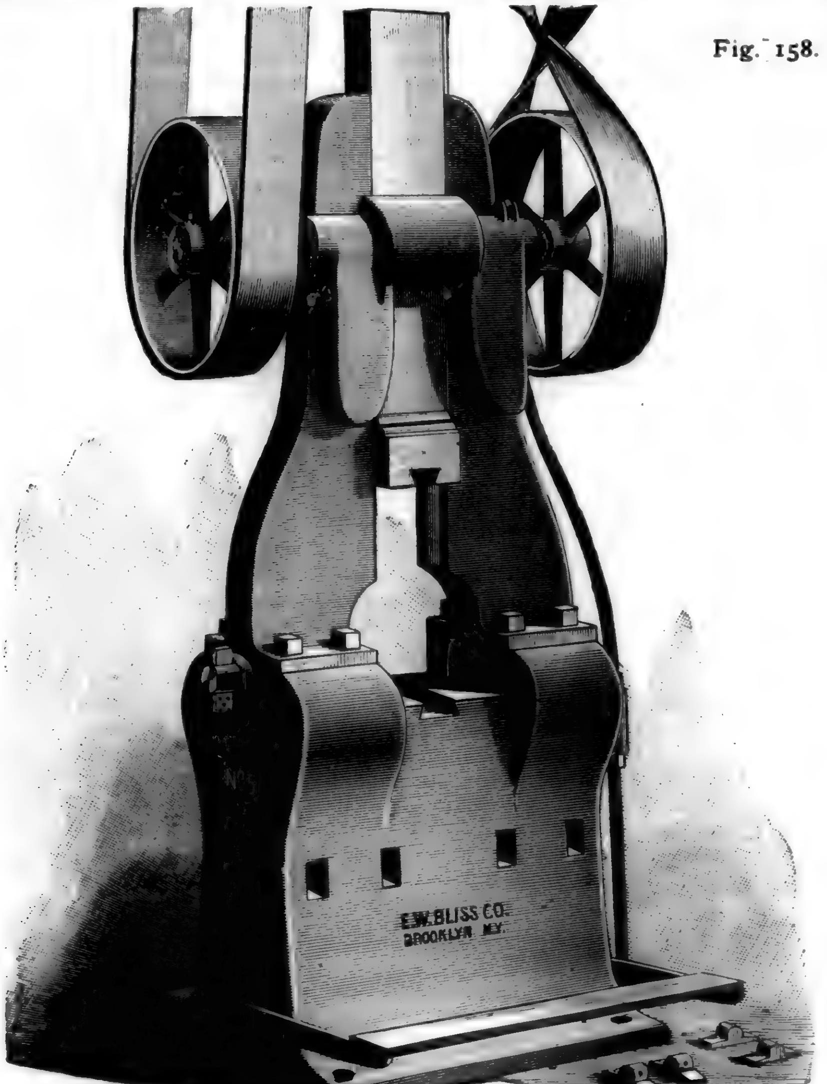
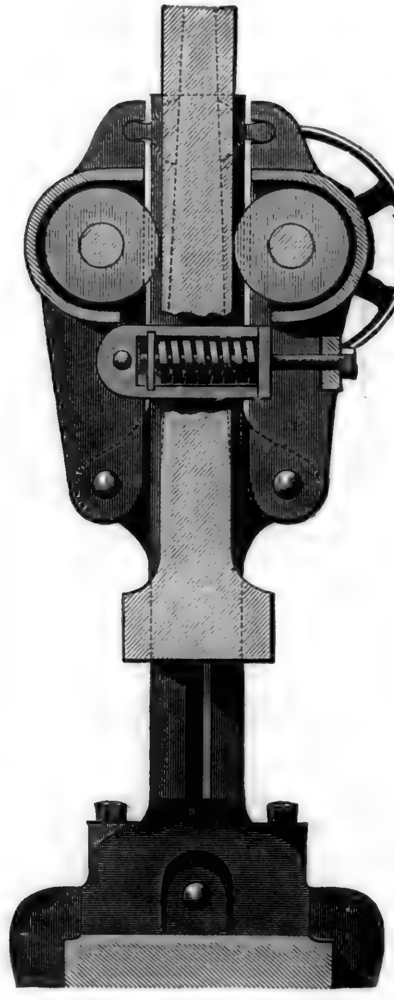


Fig. 159.



THE BLISS DROP HAMMER.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 265.)

CHAPTER LII.

THE BLISS DROP HAMMER.

Figs. 158 and 159 show a drop hammer or forging press, manufactured by the E. W. Bliss Company, of Brooklyn, N. Y. Fig. 158 is a general view of the hammer, and fig. 159 is a cross-section showing the manner in which the lifting rollers work.

The general construction of the hammer, dies, etc., does not differ materially from other hammers of the same kind, and can readily be seen from the illustrations. The rollers by which the hammer is lifted are worked by two pulleys, both run from the main shaft, one by a straight and the other by a crossed belt. The main point of difference between this and other drop hammers is the absence of any strap, board, or other attachment for the purpose of lifting the hammer. The hammer is forged of steel, and is of great length, so that the blow is concentrated over the work, which receives the entire effect resulting from its weight, and there is the further advantage that the bearings of the hammer on the guides is so extended that there is no danger of breakage when it is called upon to strike a glancing or side blow. The long bearing not only diminishes the chance of breaking the hammer, but of the guides also, as it prevents them from receiving a shock at any one point, the effect being distributed over their length. The friction rollers, instead of working on a belt or board, act directly upon this long body of the hammer itself. These rollers are carried in housings, as shown.

Instead of eccentrics or wedges a powerful compression spring is used to hold the rollers together, the arrangement of which is shown in fig. 159.

This spring device, it is claimed, has the advantage that any slight irregularity or lack of parallelism in the faces of the hammer does not interfere with its proper working, as the spring adjusts itself to such inequalities and keeps the pressure of the rollers uniform. As the rollers only require to be set back about ⅛ in., to free the hammer and allow it to fall, the spring is not liable to breakage or set, the limits of its action being so small.

The device for throwing away the rolls from the hammer and for securing the latter when at the top of its stroke is a very simple one; a long incline is placed on each side, as shown by dotted lines in fig. 159, and brass shoes are attached to the housings in which the rolls are carried in such a manner that when the hammer arrives at top of its stroke these inclines come in contact with the brass shoes, wedging the rolls apart and clear of the hammer. The pressure of the springs is thus transferred from the rolls to the stationary shoes, and the hammer is prevented from dropping back. In this way no latch or dog is required to hold the hammer in position when lifted to its full height. No bolts or screw-threads are used in the construction of the lifting device.

This hammer, it is claimed, will work very rapidly and with very little noise in comparison with ordinary hammers of the same class. When working the rolls are thrown apart, and the hammer is allowed to drop through the action of the treadle or foot-lever, shown in fig. 158; it can be dropped from any height desired, thus regulating the force of the blow.

These hammers are built in a variety of different sizes, from a small drop used for light work up to a hammer weighing one ton.

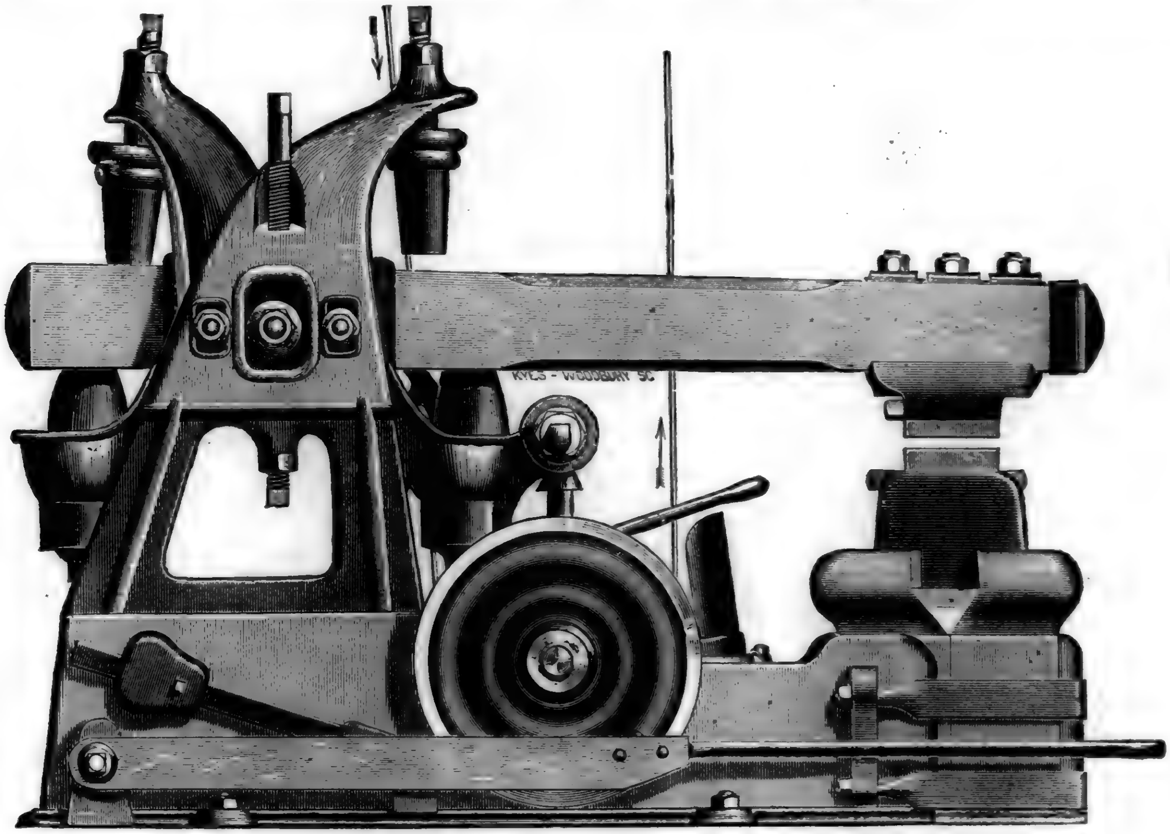


Fig. 160.

THE BRADLEY CUSHIONED HELVE HAMMER.

CHAPTER LIII.

THE BRADLEY HAMMERS.

Fig. 160 shows a helve hammer made by Bradley & Company, of Syracuse, N. Y., and known as the Bradley Cushioned Hammer, which has come into very extensive use in the United States for general forging purposes. This hammer is of the class known as helve hammers, which are, for a number of purposes, preferred to the drop or direct-acting hammer. The frame is made of cast iron; the helve is made of hickory wood, the hammer-head being attached to it by heavy bolts. It is hung upon two adjustable hardened steel centers, carried in the frame, and

derives its motion from an eccentric, consisting of an iron hub, a bronze shell and a steel strap, which is carried upon the driving-shaft. This driving-shaft is run by a belt, and is also provided with a heavy balance wheel, to which is attached a brake.

The connection between the oscillator and the helve is by a short connecting-rod provided with an adjustable sleeve-nut, so that the lift or stroke of the hammer can be readily and quickly changed at the will of the operator, and the hammer can be made to give a light or a heavy blow, as required.

The bearings of the main shaft are made of bronze, and all the others of the best anti-friction metal. The husk containing the helve can be easily raised or lowered to admit of the use of dies, varying an inch or more in thickness, without shimming up the ends of them, thus preserving the key-ways and hammer-head bolts, an advantage which will be fully appreciated by practical mechanics. that the hammer is completely under the control of the operator.

On removing the pressure the hammer is instantly stopped with the helve up, by means of the brake acting on the balance-wheel, leaving the dies apart so that the hammer is again ready for instant use.

Fig. 161 shows the Bradley Upright Hammer, which is made by the same firm, and which has some modifications in design from the helve hammer. In the upright hammer, as will be seen from the illustrations, the driving-shaft and its connecting-rod are placed on the rear end of the frame ; the hammer runs in guides carried on an arm projecting from a frame in front of the helve. Instead of being entirely of wood, as in the large hammer, the helve is made with a strap end, the connection with the hammer-head being made by a spring joined on two bolts, one at each end. This strap construction of the helve is used by the makers for all hammers up to 200 lbs. weight. For a light

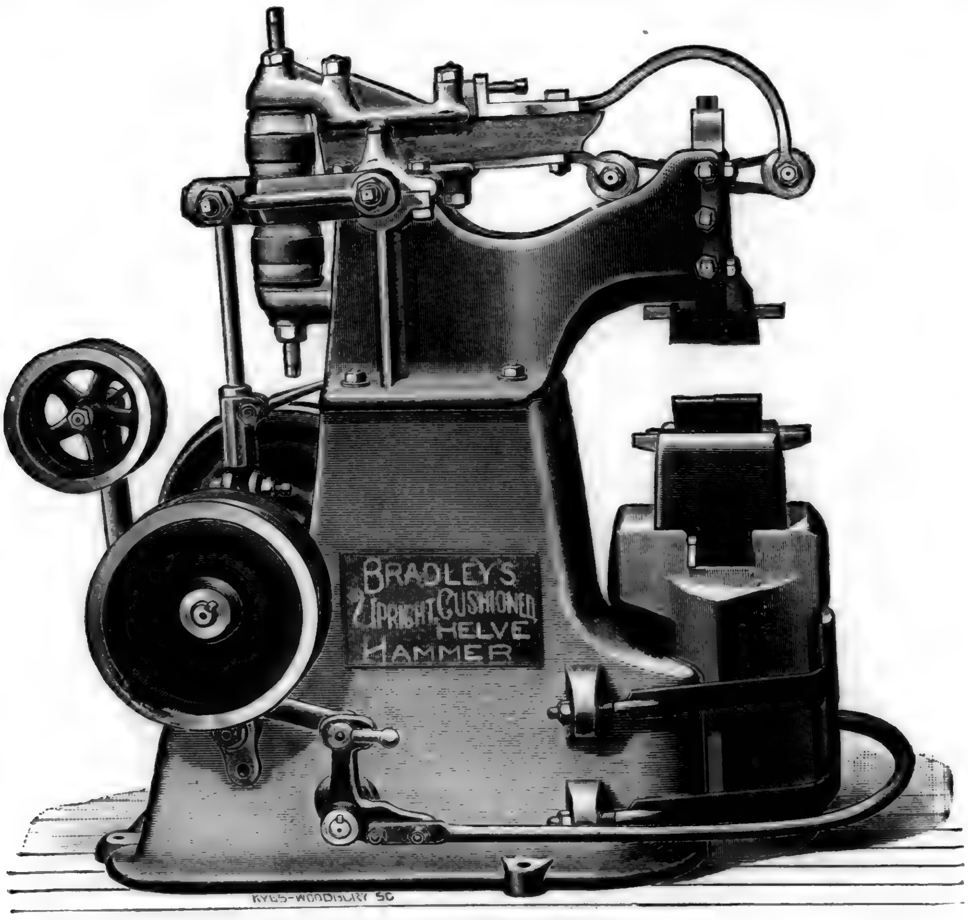


Fig. 161.

THE BRADLEY UPRIGHT HAMMER.

The oscillator and arch carry rubber cushions, so arranged as to relieve all the parts from the strain and jar caused by the concussion of the blow, besides adding materially to its power and elasticity. The tension of the rubber cushions can be regulated by means of set-screws in the upper and lower sockets of the oscillator.

The anvil-block and its foundation are entirely separate from the hammer proper, and the entire jar and concussion of the blow is received on the anvil alone, relieving all the other parts from the strain which they would otherwise sustain.

All the parts are so proportioned and so adjusted that the dead weight of the blow is evenly distributed through the parts intended to receive it.

A treadle around the bed of the hammer allows the hammerman, no matter how inexperienced, standing in front or on either side to apply the power, a gentle pressure of the foot bringing the tightener pulley in connection with the belt on the driving-pulley, from which the power is derived. The speed and power of the stroke may be varied according to the pressure applied to the treadle, so hammer this construction presents the advantage of greater compactness, the whole hammer really taking up very little more space than an ordinary smith's forge. The general principles of the adjustable connecting-rod, the eccentric motion, the fly-wheel with its brake, the regulation of the motion by a treadle, and the separate anvil-block are preserved in this hammer, the modifications being chiefly in detail. As will be seen from the cut, there is a circular opening in the frame opposite the hammer-head, which permits the handling of long bars under the hammer.

Fig. 162 shows the Beaudry Upright Power Hammer, which is built by the same firm. In this hammer, as in the other upright hammer, guides are provided in which the hammer works. The helve is forked, or made double, and is connected to the hammer by a spring or heavy strap passing over pins at the ends of the forked-arm and through a slot in the hammer-block. The helve works on large bearings carried on a frame. The driving-shaft with its eccentric is placed at the rear of the frame, and the connecting-rod is supplied with a long sleeve-nut by which

its length can be adjusted. This connecting-rod works on a projecting pin forming the rear end of the helve, but made separate from it and connected to the forward part by two bolts passing through rubber springs, which have some of the cushioning effect found in the Bradley hammer, but in a different form. The motion of this hammer is regulated by a treadle which acts through a tightening pulley, pressing it against or relieving it from the main driving-belt as required. As in the Bradley hammer, the anvil-block is separate from the frame, freeing the latter from shocks.

The construction of this hammer, which is really very simple, can be readily understood from the engravings.

These Bradley hammers are very largely in use for general forging and die work, and will be found in manufactories of arms, sewing machines, tools, agricultural instruments, and, in fact, for general forging work of all kinds. They are exceedingly useful tools, both for special purposes and for general work, and have the advantage that they can be erected anywhere where power is attainable, without the necessity of providing boilers, etc., required for a steam-hammer. They have a wide range of work, and have been generally approved in practice.

(TO BE CONTINUED.)

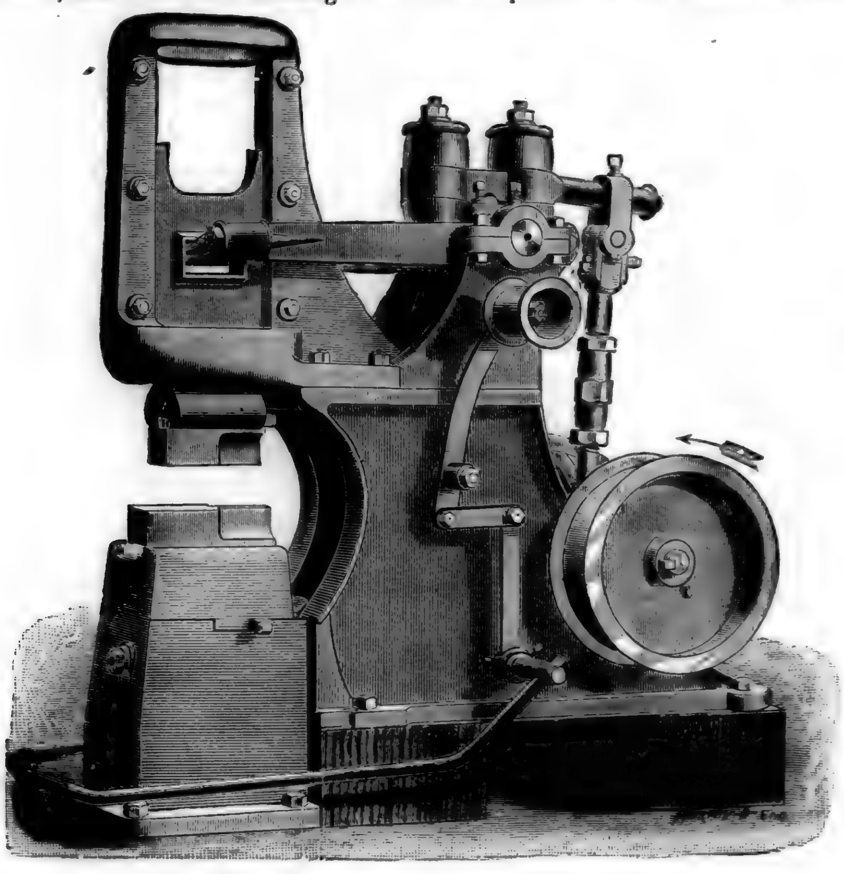


Fig. 162.

THE BEAUDRY UPRIGHT HAMMER.

NICKEL-STEEL.

(Condensed from paper by James Riley, read before the British Iron and Steel Institute).

In this paper the Author stated the result of an examination made into the new alloy of nickel and steel, made at the request of the inventors. He had visited the works in France, and seen the process of manufacture, in order to judge of the degree of certainty with which the desired product could be obtained from the crucible. Subsequently the patentees visited the works with which the Author is connected, and various charges were made, which showed that the composition of the alloy could be as effectually controlled in the open-hearth furnace as in the crucible. His experience led him to conclude that the alloy can be made in any good open-hearth furnace working at a fairly good heat. The charge can be made in as short a time as an ordinary scrap charge of steel—say about seven hours. Its working demands no extraordinary care; in fact, not so much as is required in working many other kinds of charges, the composition of the resulting steel being easily and definitely controlled. No special arrangements are required for casting, the ordinary ladles and molds being sufficient. If the charge is properly worked, nearly all the nickel will be found in the steel, and almost none is lost in the slag; in this respect it is widely different from charges of chrome-steel. The steel is steady in the mold, it is more fluid and thinner than ordinary steel, it sets more rapidly, and appears to be thoroughly homogeneous. The ingots are clean and smooth in appearance on the outside, but those richest in nickel are a little more "piped" than are ingots of ordinary mild steel. There is less liquation of the metalloids in these ingots, therefore liability to serious troubles from this cause is much reduced. Any scrap produced in the subsequent operations of hammering, rolling, shearing, etc., can be remelted in making another charge without loss of nickel. No extraordinary care is required when reheating the ingots for hammering or rolling. They will stand quite as much heat as ingots having equal contents of carbon but no nickel, except perhaps in the case of steel containing over 25 per cent. of nickel, when the heat should be kept a little lower, and more care taken in forging. If the steel has been properly made, and is of correct composition, it will hammer and roll well, whether it contains little or much nickel; but it is possible to make it of such poor quality in other respects that it will crack badly in working, as is the case with ordinary steel.

A table appended to the paper gives the result of tests of 12 different specimens of the alloy, with nickel varying in proportion from 1 up to 49.4 per cent.

The quality of hardness obtains as the nickel is increased, until about 20 per cent. is reached, when a change takes place and successive additions of nickel tend to make the steel softer and more ductile, and even to neutralize the influence of carbon. A series of hardening and tempering tests show the possibility of very largely raising the break-

ing strain and elastic limit, and the hardness of these alloys.

One piece tested gave: Breaking strain, 95.6 tons; elastic limit, 54 tons; extension (in 4 in.), 9.37 per cent.; contraction of area, 49.2 per cent. Other pieces gave nearly parallel results.

The new alloy has an advantage over ordinary steel, because it does not so easily corrode. Steels rich in nickel are, in fact, non-corrodible; and those poor in nickel are still much better in this respect than ordinary steel.

Alloys up to 5 per cent. of nickel can be readily worked in the lathe or planer, but richer alloys are more difficult to work. Poor alloys stand punching very well. The 1 per cent. nickel steel welds fairly well, but richer alloys do not weld easily.

The Author then refers to the theory regarding the molecular constitution of the alloy. It was supposed that it consisted of crystals of metallic iron, cemented together by carbide of iron and nickel, which "cement" fills the space between the crystals more completely than carbide alone in ordinary steel, and thus a more powerful cohesion is obtained.

Referring to the possible uses of the new alloy, the Author thought that the richer alloys would be extensively employed in the field covered by what is usually termed the "metal trades." The 25 per cent. alloys he considered well adapted for all operations entailing considerable deformation, such, for instance, as deep stamping and flanging, while their non-corrodibility will render them useful in all cases where the cost of metal is of minor importance as compared with the cost of labor. Alloys containing between 25 and 5 per cent. of nickel might be used for tool steel, but the alloys containing less than 5 per cent. will have a more general application. Recent advances in marine engineering had only been possible because in steel the engineer had a superior metal at his command, and improvement in the same direction was bound to follow from the introduction of a new material even better than steel. A metal having when annealed an ultimate strength some 30 per cent. higher than steel, and an elastic limit some 60 to 70 per cent. higher, with equal ductility and less liability of corrosion, offered very large advantages. The new metal was also very valuable for armor-plates, and the Author exhibited a small armor-plate made of nickel steel.

In the discussion it was stated that gun-barrels made of nickel-steel stood very high tests. A 6-in. gun of this metal had been ordered by the English Government.

An objection suggested in the discussion was the cost of nickel, and the fact that the commercial metal was usually impure, containing copper and silicon. This objection, however, was not considered important.

AN INSPECTION LOCOMOTIVE.

THE accompanying illustrations show a small inspection locomotive, or combined locomotive and car, recently built by the Schenectady Locomotive Works for the Delaware & Hudson Canal Company, and intended especially for the use of the Superintendent of the lines of that Company. In these illustrations, fig. 1 is a perspective view, fig. 2 is a sketch of the elevation, showing the position of the boiler, etc., and fig. 3 is a plan, showing the arrangement of the locomotive and car.

As shown on the elevation, the length of the engine, measured between the extreme points of the two pilots, is 41 ft. 5 in.; the extreme wheel-base is 26 ft., and the rigid wheel-base, measured between the center of the four-wheeled truck and the center of the driving-wheels, is 14 ft. 2 in. It is carried on a single pair of driving-wheels, a two-wheeled or pony truck in front and a four-wheeled truck under the rear end of the car. The car body extends the whole length of the machine, the forward end thus forming a cab for the engineer and fireman, and preserving a symmetrical appearance for the whole.

Fig. 2.

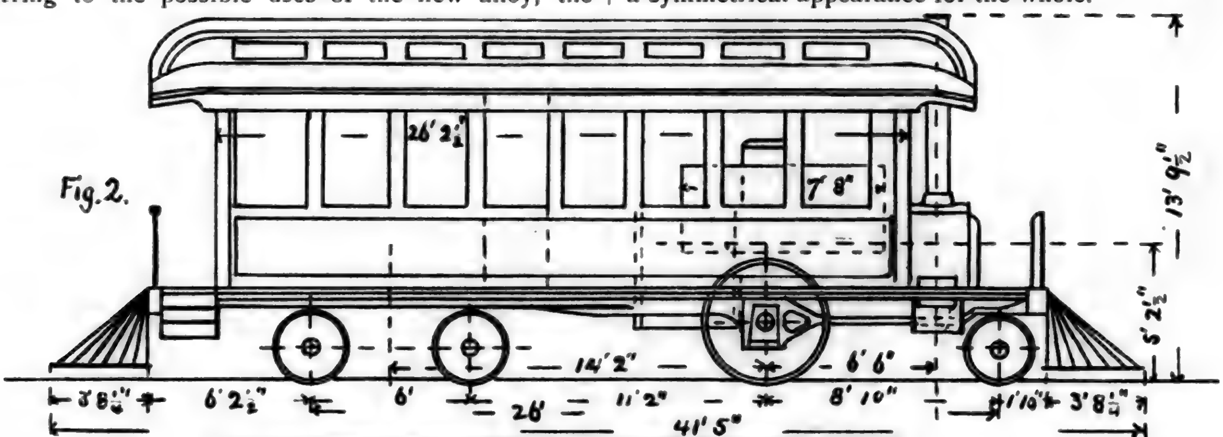
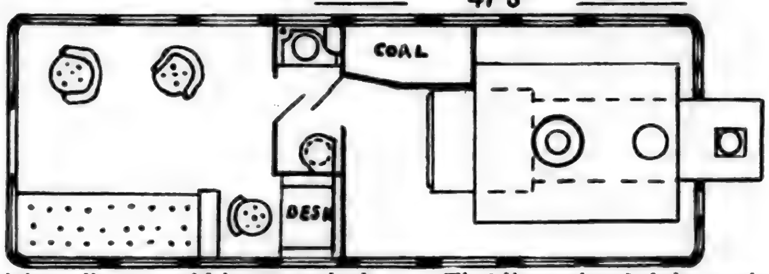


Fig. 3.



The dimensions of the engine are as follows:

Diameter of boiler	36 in.
Length of fire-box	40 "
Width of fire-box	36¾ "
Depth of fire-box	44 "
Number of tubes	102
Outside diameter of tubes	1¾ in.
Length of tubes	6 ft. 6 "
Grate surface	10.2 sq. ft.
Heating surface, fire-box	46.5 " "
Heating surface, tubes	299.8 " "
Heating surface, total	346.3 " "
Material of boiler	⅜-in. steel
Diameter of cylinders	9 in.
Stroke of cylinders	16 "
Size of steam-ports	7 × 0⅞ "
Size of exhaust-ports	7 × 1½ "
Outside lap of valve	0½ "
Inside lap of valve	0 1/32 "
Throw of eccentrics	3⅝ "
Greatest travel of valve	3¾ "
Diameter of driving-wheels	54 "
Diameter of front truck-wheels	28 "
Diameter of back truck-wheels	30 "
Size of driving-axle journals	6 × 8 "
Size of front truck journals	4½ × 8 "
Size of back truck-journals	3¾ × 7 "
Total weight in running order	63,000 lbs.
Total weight on drivers	26,000 "
Water capacity of tank	500 gals.
Coal capacity of fuel-box	2,000 lbs.

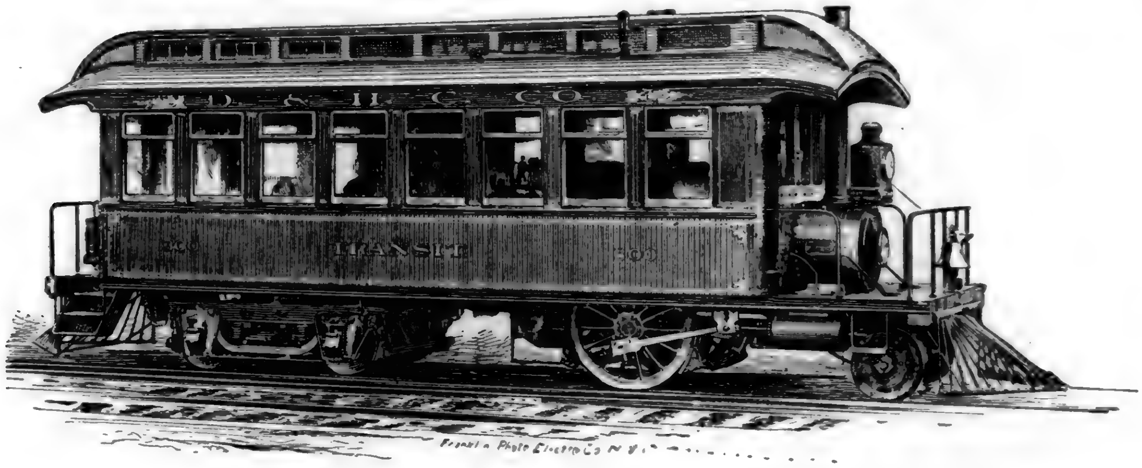
The front truck is of the swing-bolster pattern, and the back or four-wheeled truck of the rigid-center type. The engine will pass with ease curves of 300 ft. radius.

The water is carried in a saddle tank 7 ft. 8 in. long, which is placed over the boiler, as shown in the sketch, and the coal in a box in the engineer's compartment of the car.

The car is abundantly provided with windows at the side, as shown. At the rear end, and opening on the platform, the windows at each side of the door and also in the door are of heavy plate-glass, and extend to within 1 ft. of the floor, affording an unobstructed view of the track. A large window between the inspection-room and the engine-room gives the engineer a clear view of the road when running, with the inspection-room end of the locomotive forward. The inspection-room is 9 ft. 6 in. long by the full width of the car, and is fitted with a toilet room complete; with a writing-desk, three drawing-room car seats, a sofa, and a full outfit of lamps, books, etc. The inside wood-work is of mahogany, and the room is finished in handsome style. The general arrangement is shown in the plan; the lounge is movable, and can be made into a bed if required at night. The chair shown between the desk and the lounge on the plan is not fixed to the floor, but can be moved whenever required, and, as will be seen, there is room to put in additional chairs should they be needed at any time.

This engine has frequently made 45 miles an hour, and has been run up to 60 miles an hour; the provision of coal and water is sufficient for a long run, and everything necessary for a protracted trip over the road can be carried.

The whole arrangement is very complete, and very well designed for the purpose for which it is intended. Since it has been delivered to the Delaware & Hudson Canal Company it has been in constant use, and has given excellent satisfaction.



INSPECTION LOCOMOTIVE.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS.

THE CLARK MILLS FURNACE—A REMINISCENCE.

By A. Vivarttas.

Clark Mills built a furnace: a furnace not described in the books, but which should be. Who was Clark Mills? How came he to build such a furnace? And what was that furnace like?

Clark Mills, to tell the story in nearly his own words, was born in New York State, some 12 miles or so from Utica, and had relatives living there at the time of the narration.

He was twice married, having by his first wife four sons. While yet a young man he drifted out to Charleston, S. C., where he followed the trade of plastering, and finished the walls of interiors with scagliola. Business getting dull, he became somewhat interested in politics. But one night, after a consultation with some of the leaders, he found when he started to go home that he could not walk straight. He stopped, and leaned against a hitching-post until he could walk erect. Meantime he thought that this had gone far enough; it was time to make a change. Plastering was dull, but he could handle plaster, and it must pay him somehow.

At that time there lived in Charleston a saddler and harness-maker, who was one of the characters of the place, and who, by a habit of drawing his mouth to one side as he stretched his stitches, had got a comical kink in one side of his face. Clark Mills got him for his first subject, and modeled his portrait in plaster. The likeness was universally recognized and approved; Mills soon got a commission for a bust, charging the modest price of \$20. The business grew; he raised his price to \$25, and in a few months some Charleston gentlemen, who were willing to encourage home talent, raised a subscription to enable him to make a bust of John C. Calhoun, who was then very popular there.

The bust, upon completion, was given to the city, and the Municipal Government presented Mr. Mills with a gold medal valued at \$2,000. His friends now advised him to visit Italy, and a fund was raised for that purpose, and he started; but visiting Washington on his way North, the Committee of Congress, who had in charge the matter of a proposed equestrian statue to Andrew Jackson, asked him to offer a design therefor. He had never attempted such a subject, and declined; but the idea ran in his head, and after sleeping over it he determined to try, and making a small model, submitted it to the Committee.

It was accepted, and he received the commission, the price to be \$12,000. Mills now set to work on a full-sized model, and communicated with the brass-founders, for the statue was to be of bronze; the Government having agreed to supply some old guns that had been brought from Mexico for the purpose.

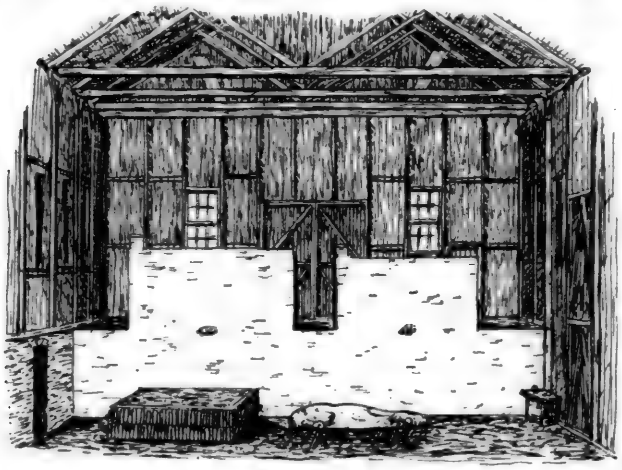
But none of the American founders would take so large and difficult a job at any price that Mr. Mills felt justified in paying, and so he started in to learn the brass-founder's business, to cast it himself. The Government would let him use the furnaces at the Navy Yard; but when the authorities there found that he wanted to dig a pit 15 ft. deep, to sink his mold below the furnace level, they became alarmed for the safety of the foundations of the furnace, and he determined to construct a furnace of his own.

So Clark Mills came to build a furnace. This Mr. Mills was blest with a fairly good memory, and studying over the best authorities upon the subject of bronze-melting, he came to the conclusion that their plans were unnecessarily expensive. And he bethought him how, when a boy of 15, he had been with a gang of men burning charcoal, and how the lost log chain was found when the pit was burnt and emptied, it having been accidentally covered in the bottom of the pile, and lain there through the burning.

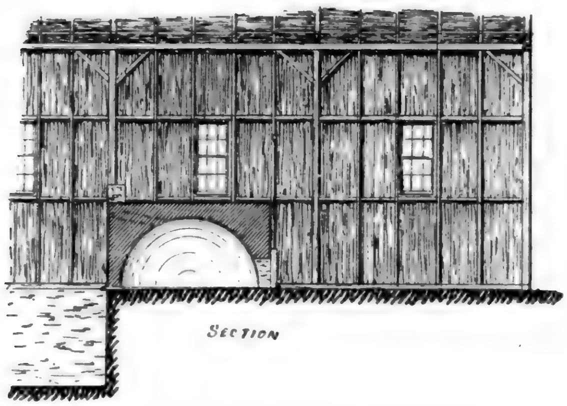
But of that log chain Clark Mills also recollected that not only were the wrought-iron links melted and run together, but that pieces of brick that lay in contact with them were also melted, and so fused with the iron that they could not be separated nor distinguished from each other at the juncture.

Said Mr. Mills, "I had heard ministers preach of hell, and I wondered how much hotter hell was than the bottom of a charcoal pit."

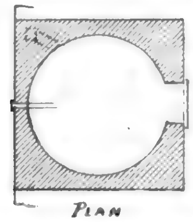
Anyway Mr. Mills, wanting a bronze furnace, remembered his youth, and he took courage and said, "I will melt those guns in a charcoal pit. A coal pit burns wood; wood I can have. A coal pit uses no chimney; no chimney will I use. A coal pit is covered with earth to confine the



ELEVATION



SECTION



PLAN

heat and gases; I will build my furnace of brick or baked clay, that it may retain its form for another time. In that alone will I depart from the charcoal pit plan."

Mr. Mills commenced his furnace upon the ground where the south front of the Treasury Department now stands. He consulted the scientific men and authorities of the day. He stood alone; his plan was condemned unanimously as a scheme that could not possibly succeed. Among those who put themselves on record to that effect were Professor Joseph Henry, of the Smithsonian Institute, and Professor Page, of Washington. The latter not only condemned the plan of the proposed furnace, but also bitterly criticised the design of the proposed statue, asserting that if made as designed the statue would not have strength to hold up its own weight.

So much noise was made upon this point, that Mr. Mills made a small model of his design, and cast it in bronze without core, and visiting Professor Page set it before him, and asked him, "If this model, which is solid, stands upon its legs, as you see, why will not the large statue, with solid legs and hollow body, stand also?" Yet it may be mentioned that to this day there are those who imagine (falsely) that there are iron rods in the legs of that statue to strengthen them.

Clark Mills, however, with commendable firmness kept on his course and constructed his furnace, and at the first heat melted down 6,000 lbs. of bronze with three-eighths of a cord of pine-wood; casting four bells, one of which was sent to the Navy Yard, and one, I think, to the Smithsonian Institute. One he kept, and afterward used on his place near Bladensburg—the only bell, by the way, the writer ever heard time farm-hands to their work at 10 hours per day.

The writer has forgotten the location of the fourth of those bells. But when Mr. Mills told Professor Henry of his success, the Professor held up both hands with astonishment.

Mr. Mills now went on, and cast in this furnace the statue of General Jackson now standing in Lafayette Square, in front of the President's house, in Washington.

Of that statue it may be remarked that, in spite of a great deal of adverse criticism, which was based upon artistic and some political jealousy, it has no superior in artistic merit in the known world to-day.

Clark Mills is dead, but his work outlives his critics.

Without going into a detailed description of a work which all may inspect for themselves, there is one feature in connection therewith which, as being of engineering interest, should be noted here. The statue of General Jackson, in Lafayette Square, stands upon a monolithic pedestal measuring 15 × 15 × 18 ft., and weighing more than 120 tons. It is of granite from the State of Maryland, and was brought to Washington over the Washington Branch of the Baltimore & Ohio Railroad, and was, at the date of its erection in 1851, the heaviest stone ever handled in the United States; and it has few equals to-day.

In this matter also Mr. Mills asserted himself. His army of officious advisers did not forget to tell him that 120 tons, on a base 15 × 18 ft., required a good masonry foundation, so many feet deep and wide, to carry it.

Mr. Mills said, "A built-up pedestal might need a strong floor, to prevent unequal settling and consequent rupture; but I have seen many a bigger boulder lie upon the ground intact."

And upon the ground he set that pedestal; and after more than a generation we may say that he did well.

This statue having been finished and accepted, Mr. Mills found himself somewhat out of pocket, and Congress voted him about $25,000 additional.

He now secured an estate upon the Bladensburg turnpike, and erected a studio and foundry. The first studio, a wooden building, was destroyed by one of those sudden squalls that occasionally drop down upon the District of Columbia, rolling tin roofs up like carpets, and landing them carefully in the tops of trees, out of the way of the passers in the streets.

He rebuilt his studio of brick, and its large doors and octagon form made it a prominent landmark from both railroad and turnpike. On the other side of the railroad he located his foundry, and constructed therein two furnaces of his peculiar design; the accompanying cuts thereof are sketched from memory of many years, but are correct in all essentials. The larger furnace had a hearth of brick about 8 ft. in diameter, and was nearly hemispherical in its internal form. There was a door some 2 ft. square on one side at the bottom, which, with a small channel for drawing off the molten metal, and a chimney-flue about 8 in. square to assist in starting his fire, were all of the openings. The exterior was a plain brick block 10 ft. square and 6 ft. high, the chimney only rising about 16 in. more.

The smaller furnace was precisely similar in form and arrangement, but its inside diameter was only about 6 ft.

These furnaces were located, as shown, upon a bank wall 6 or 7 ft. high, thus obviating the necessity of digging pits

for his molds. The foundry was also supplied with ovens for drying molds and cores, two cranes, etc.

Here Mr. Mills cast the *replica* of his Jackson statue, which is now standing in the city of New Orleans, taking it out there and inaugurating it in the spring of 1856, some months before the statue of Washington, by Brown (the third equestrian statue cast in this country), was inaugurated in Union Square, New York. Mr. Mills also cast another of the Jackson statues, which was intended for Nashville, Tenn. But the Civil War intervened before the matter was consummated.

Here also Mr. Mills modeled and cast the statue of Washington, which stands in the circle as you go up Pennsylvania Avenue toward Georgetown. This was also a Government commission, and was inaugurated February 22, 1860.

The next year Mr. Mills let his foundry to the Government, and upon a salary cast and finished the statue designed by Crawford, which adorns the dome of the Capitol, and is popularly supposed to typify Columbia. In regard to this statue there is one curious point. The left hand of the figure rests upon a shield, generally supposed to be the escutcheon of the United States, but incorrectly bearing 13 stars in the "chief," which have no business there, and having 15 "pales" or stripes in the field, in place of the 13 which should be there. Mr. Mills, when this was pointed out to him, admitted the fact, but took no responsibility for the design he was carrying out, and afterward passed the matter off as of little consequence, while the majority of the people or Government officers could not correct him to-day.

When Mr. Mills came to cast the statue of Washington, above mentioned, he wished to mix his own bronze, and then constructed reverberatory furnaces, which he used in casting both the statue of Washington and the apex of the dome of the Capitol.

With regard to the efficiency of the Mills chimneyless furnace, one incident may be told. It happened while casting the Jackson statue for New Orleans. One night the molds were ready, the heat and metal nearly ready to pour, when Mr. Mills was called into the house and detained for half an hour or more. Hurrying back, and concerned for his castings, he opened the door of the furnace and thrust in the slice-bar, to find his metal all gone, and the brick bottom of his furnace melted. He "shoveled it up like mush."

He was compelled to cool down, tear out the bottom or hearth of his furnace, and rebuild. That furnace bottom lay in the lot near the studio from 1856 to 1859, a perfect honeycomb of bronze, full of vitrified brick, with the marks of the slice-bar, where he had searched for his metal. It was about 8 ft. in diameter, and near a foot thick; when struck it would ring like a deep toned bell.

While casting the statue of Washington, in the fall of 1859, Mr. Mills gave two of his men an overtime job to break it up, he supplying the fuel—it being, of course, "hot short"—and sledges, and paying them so much a pound for the metal; and it kept them busy at night for some weeks.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(Continued from page 290.)

CHAPTER XXX.

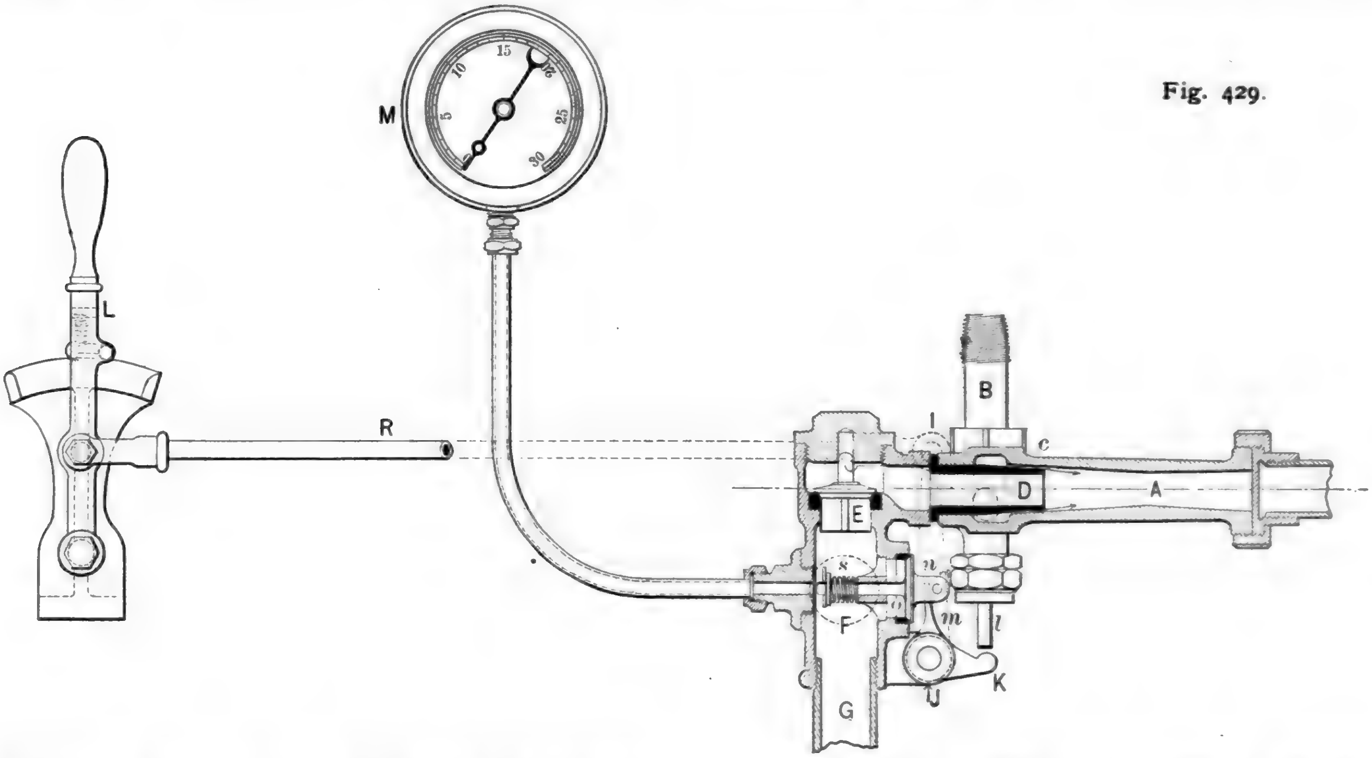
THE EAMES VACUUM DRIVING-WHEEL BRAKE.

Question 736. *What difference is there in the principle of working of vacuum and air-brakes?*

Answer. In air-brakes the force which applies the brakes is exerted by air of a pressure considerably greater than that of the atmosphere, whereas in vacuum brakes the force is exerted by ordinary atmospheric pressure.

Question 737. *By what means is the atmospheric pressure exerted to apply the brakes?*

Fig. 429.



Answer. The air is exhausted from a cylinder or other vessel, so that the pressure of the atmosphere acts on the opposite side of a piston or diaphragm, and thus exerts the requisite force to apply the brakes.

Question 738. *How is the air exhausted?*

Answer. Usually by means of an instrument called an "ejector."

Question 739. *How is an ejector constructed and how does it operate?*

Answer. It consists of a tube, *A*, fig. 429, to which a current of steam is admitted by the pipe *B*. The steam enters the tube through the annular space *c c* around the internal nozzle *D*, as is indicated by the darts. This produces what is called an "induced current" of air through the tube *D*, or, in other words, the steam escaping into *A* draws the air in *D* after it, and thus produces a partial vacuum above the valve *E*, and the air pressure below raises the valve, and the air is then exhausted from the space *F* below it and from the pipe *G*, and from a diaphragm vessel, with which the pipe *G* is connected.

QUESTION 740. *How is the diaphragm arranged and how does it operate?*

Answer. Fig. 431 represents the diaphragm vessel *H*, the lower portion being shown in section. It has a wide open mouth, with a flange, *b b*, around it. This open mouth is covered by an india-rubber diaphragm, *d d*, which is attached to the flange *b b* by a ring below it and bolts shown in the engraving. The diaphragm has two metal plates in the middle, with

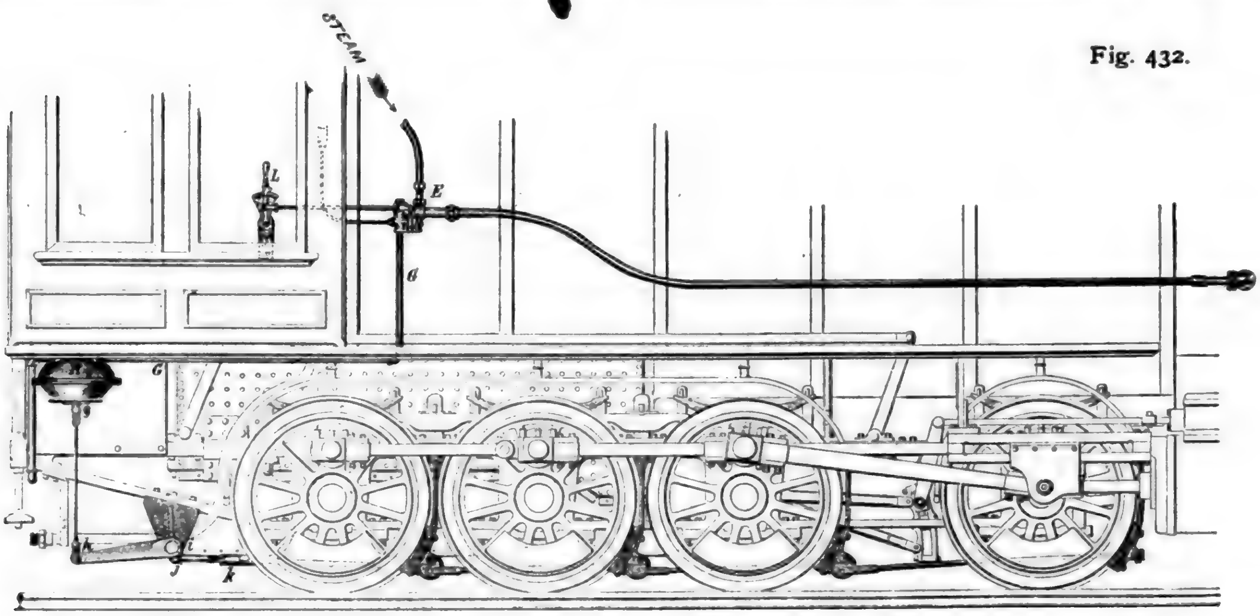


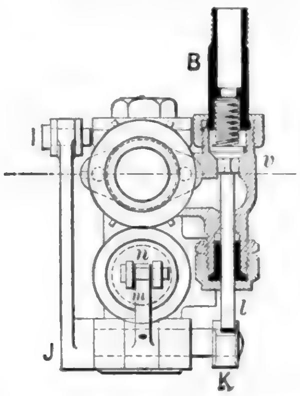
Fig. 432.

an eye, *g*, fastened to the plates by a nut, which holds the plates and diaphragm together.

QUESTION 741. *How do the ejector and diaphragm operate to apply the brakes?*

Answer. The ejector is placed in any convenient position on the engine—usually on the side of the fire-box, as shown at *E*, fig. 432. The pipe *G G* of the ejector is connected to the

Fig. 430.



diaphragm vessel *H*, and the eye *g* on the diaphragm is connected by a rod, *g h*, to the arm *h i*, which is attached to a shaft, *i*. This shaft has a short arm, *i j*, which is connected to the brake-shoes by a rod, *k*. *L* is the brake-lever located inside of the cab, and shown on an enlarged scale in fig. 429. Steam is admitted to the ejector by a valve, *v*, fig. 430, which is attached to the stem *l*. This valve is operated by means of the brake-lever *L*, fig. 429, which is connected by a rod, *R*, to an arm,

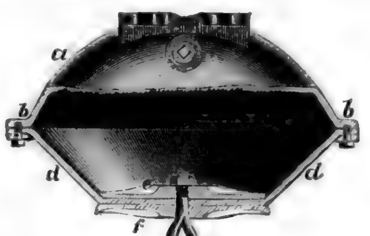


Fig. 431.

I J. This arm is attached to a shaft, *J*, which has a short arm or toe, *K*, connected to it. When the lever *L* is moved backward or toward the left-hand side of the engraving, the toe *k* lifts the spindle *l* and valve *v*, fig. 430, which admits steam to the annular space *c c* of the ejector, and its escape produces a partial vacuum in the pipe *G* and diaphragm vessel *H*, fig. 432, as has been explained. When this occurs the air below the india-rubber diaphragm presses it upward, and this pressure is communicated to the brake-shoes through the connections *g h i j* and *k*. When the brakes have been applied sufficiently the lever *L*, fig. 429, is moved forward, or toward the right in the engraving, to the middle position in which it is shown. This lowers the toe *k* and allows the steam-valve *v* to close. When the current of steam is shut off the air flows into the pipe *A* and nozzle *D*, and its pressure on top of the check-valve *E* closes it, and retains the vacuum in the pipe *G* and diaphragm vessel *H*.

QUESTION 742. *How is the brake released?*

Answer. The lever *L* is moved still farther forward, from the position in which it is shown in fig. 429. This moves the shaft *J*, which has an arm, *m*, that engages with a pin, *n*, attached to a release-valve, *o*, and this action opens the valve. The air then flows into the ejector *F*, pipe *G*, and diaphragm vessel *H*, fig. 432, and equalizes the pressure above and below the diaphragm and releases the brakes. The release-valve *o* has a spring, *s*, on its spindle, to close it when the lever *L* is moved back to the position shown in fig. 429.

M is a pressure gauge to show how much the pressure has been reduced in the ejector.

QUESTION 743. *How much pressure can be exerted on the brakes by the ejector and diaphragm?*

Answer. This depends upon the size and number of the diaphragms. The manufacturers of this brake recommend that for driving-wheels—for which purpose it is chiefly used—that a

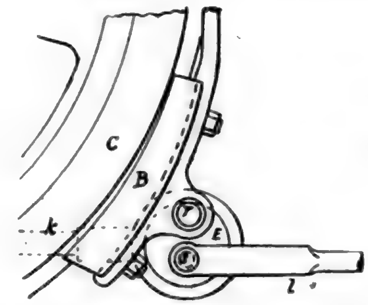


Fig. 433.

pressure upon the brake-shoes equal to about 65 per cent. of the weight on the wheels should be employed.

QUESTION 744. *How is the pressure on the brake-shoes of the different wheels equalized?*

Answer. The rod *k*, fig. 432, is connected to a circular disc, *E*, fig. 433, which has two shafts or spindles, *r* and *s*, which are located eccentrically or on each side of the true center of the disc. When a strain of tension is exerted on the rod *k* it draws the brake-shoe *B* against the wheel *C*, but at the same time it exerts a tension on the rod *l*, which is communicated to the shoe on the next wheel, and to as many more as have the brakes applied to them.

QUESTION 745. *For what service is the vacuum brake most used?*

Answer. It is now applied chiefly to the driving-wheels of

locomotives, but is also used on short trains which make frequent stops, as on the elevated railroads of New York.

CHAPTER XXXI.

DIFFERENT KINDS OF LOCOMOTIVES.

QUESTION 746. *Into what classes may locomotives be divided conveniently?*

Answer. 1. Locomotives for "switching," "shunting," or "drilling" service—that is, for transferring cars from one place to another at stations; 2, for freight traffic; 3, for ordinary passenger traffic; and 4, for metropolitan or suburban railroads, where a great many light trains are run.

QUESTION 747. *What kinds of locomotives are used in this country for switching cars at stations?*

Answer. Four and six-wheeled locomotives similar to those shown on page 88 of the current volume of the JOURNAL. Such engines are now usually made with separate tenders, but they are sometimes made so as to carry the water-tank and fuel in the locomotive itself, and are then called tank locomotives.

QUESTION 748. *Why are four and six-wheeled locomotives used for switching?*

Answer. Because in such service it is necessary to start trains often, many of which are very heavy, and therefore a great deal of adhesion is needed. For this reason the whole weight of the locomotive and, in the case of tank locomotives, that of the water and fuel, is placed on the driving-wheels. It is also necessary for such locomotives to run over curves of very short radius and into switches whose angle with the main track is very great; and therefore, in order that they may do this and remain on the track, their wheel-bases must be very short, and consequently the wheels are all placed near together and are usually between the smoke-box and fire-box.

QUESTION 749. *Why are such locomotives not suited for general traffic?*

Answer. Owing to the shortness of their wheel-bases they become very unsteady at high speeds, and acquire a pitching motion, similar to that of a horse-car when running rapidly over a rough track. This unsteadiness not only becomes very uncomfortable to the men who run the locomotive, but when it occurs there is danger of the engine running off the track. As nearly all switching is done at very slow speeds, it is not so objectionable for that service as it would be on the "open road"* at high speeds.

QUESTION 750. *How can such engines be made to run steadier?*

Answer. By putting a pair of truck-wheels under the front or rear end of the engine, as shown on page 89 of the current volume of the JOURNAL.

QUESTION 751. *What kinds of locomotives are used for passenger service?*

Answer. The greater part of the passenger service of this country is performed by locomotives like that selected for the illustrations of these articles, and represented in Plates III, IV, and V. Such locomotives have been called "American" locomotives, because they first originated in this country, and are now more generally used here than anywhere else. Perspective views of similar engines are also shown on page 234 of the current volume.

QUESTION 752. *How are such engines constructed?*

Answer. One pair of driving-wheels is usually placed behind the fire-box and one in front, and the front end of the engine is carried on a four-wheeled truck. In some cases the fire-box is extended back over the top of the rear axle. Usually the fire-box is placed between the frames, but they are sometimes put on top, in order that it can be made wider than is possible if it is placed between.

QUESTION 753. *What are the dimensions of such engines?*

Answer. The principal dimensions of the engines illustrated on page 234 are given below the engravings, but locomotives of this plan are built of much smaller and also of larger sizes than those represented by the engravings. In some cases they do not weigh more than 35 or 36,000 lbs., with cylinders from 8 to 12 in. in diameter. In other cases they weigh over 100,000 lbs., with cylinders 18 or 20 in. in diameter. The wheels vary from 4 to 6 ft. in diameter, but the most common sizes are 4½ to 5½ ft.

QUESTION 754. *What kinds of locomotives are used for freight service?*

Answer. Much of the freight service in this country is performed by "American" locomotives, similar to those described for passenger traffic. Usually engines used for freight service have smaller driving-wheels than those designed for passenger trains.

* The term "*open road*" is a literal translation from the German, for which there is no corresponding English term, and means the road between stations where trains run fast.

QUESTION 755. *When it is desirable to pull heavier loads than is possible with the adhesive weight that can be placed on four driving-wheels, what is done?*

Answer. One or more pairs of driving-wheels are added, as in the ten-wheeled and "Mogul" locomotives represented on page 235, and the "Consolidation" and twelve-wheeled engines on page 238, and the "Decapod" locomotive on page 335. The ten-wheeled locomotive is similar in construction to an ordinary "American" locomotive, excepting that it has another pair of driving-wheels in front of the main driving-wheels. It will be seen, however, that it is necessary to keep these close to the latter, because if they are brought further forward they will be too near the back truck-wheels. For this reason a truck consisting of a single pair of wheels is substituted in place of the four-wheeled truck and is placed in front of the cylinders, as represented in the engraving of the Mogul engine on page 235, and the front pair of driving-wheels can then be moved further forward, and they thus bear a larger proportion of the weight than they do if located as they are under the ten-wheeled engine. There is a similar difference between the construction of the twelve-wheeled and "Consolidation" engines shown on page 288.

QUESTION 756. *Under what circumstances are the different classes of freight locomotives which have been described employed?*

Answer. On comparatively level roads, or those having a light business, "American" locomotives are generally used for freight as well as passenger business. On lines which have moderately heavy grades or heavy traffic, ten-wheeled and Mogul engines are used; and where the grades and the traffic are both heavy, Consolidation or twelve-wheeled engines are employed. For excessively heavy mountain grades, Decapod locomotives are employed. For working some exceptionally heavy grades in India, twin engines, shown on page 333, have recently been built in England. These consist of two locomotives, each with three pairs of driving-wheels, coupled to a single double-ended tender between them, as shown in the engraving.

QUESTION 757. *What is meant by metropolitan and suburban railroads? What is the nature of their traffic?*

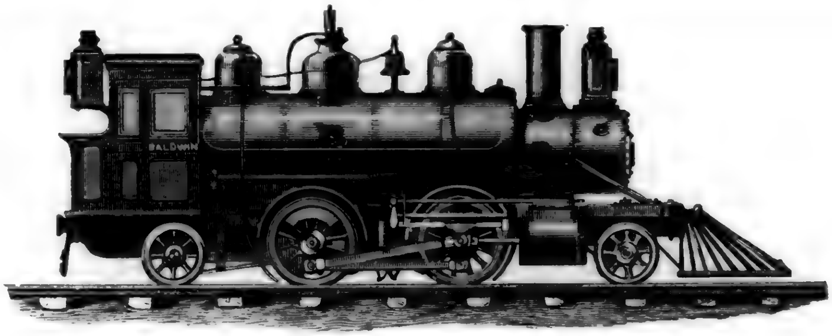
Answer. By metropolitan railroads are meant railroads in large cities. They may be divided into two classes: one for carrying freight cars from the outskirts of cities to the warehouses and stores at their business centers, and also from the terminus of one road to that of another. Metropolitan railroads of this kind are usually branches of lines which extend from the city. Locomotives for such traffic must have great tractive power, in order to pull heavy trains; and as the speed is usually slow, the wheels and the boiler capacity may be small. They must generally be capable of running through curves of very short radius; and as the traffic is usually carried through streets in close proximity to buildings, the locomotives should be as nearly as possible noiseless. The other class of metropolitan roads is for carrying passengers. The traffic of the latter is similar to that usually carried on horse railroads, and consists almost exclusively of passengers. Many light trains must be run at short intervals and at comparatively slow speeds, and therefore very light locomotives are required.

The traffic of suburban railroads consists chiefly of the transportation of passengers, who do business in a city, to the latter in the morning and to their homes in the evening. As the largest number of passengers must be carried during a few hours in the morning and evening, it is necessary to run very heavy trains at those times. As the passengers must be distributed at many stations which are near together, it is necessary to stop often; and in order that the average speed may be reasonably fast, the trains must run very rapidly between these stations. It is, therefore, essential to have heavy locomotives, with more than the usual proportion of adhesive weight, so that the trains can be started quickly without slipping the wheels. The main valves should also have a liberal amount of travel, so that steam will be admitted to and exhausted from the cylinders quickly. In some cases it is thought desirable to have locomotives which will run equally well either way, so that it will not be necessary to turn them around at each end of the "run."

QUESTION 758. *What kinds of locomotives are used on metropolitan railroads?*

Answer. For freight traffic ordinary switching locomotives, like that shown on page 88, are often employed. In some cases these have the water-tanks on the locomotives. It often happens though that such traffic must be conducted in the streets of a city, and that the noise, especially of the exhausting steam, is thus liable to frighten horses and disturb the occupants of the houses. It is, then, necessary either to condense the exhaust steam or render its escape noiseless, which is done by allowing it to escape into the water-tanks. Street locomotives which have a condenser similar to the surface condensers used on marine en-

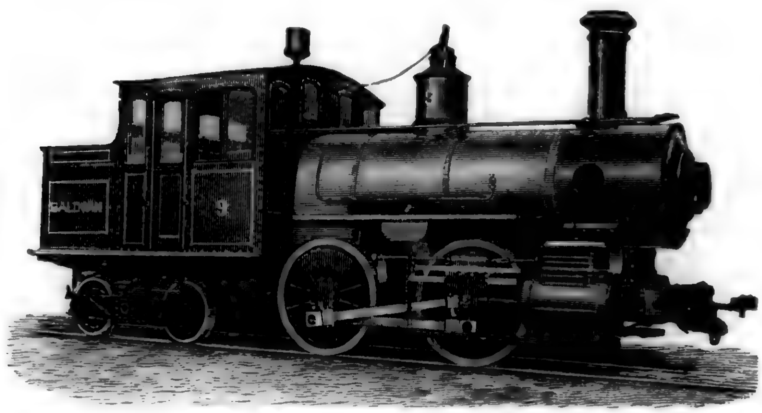
Fig. 434.



TANK LOCOMOTIVE FOR PASSENGER SERVICE.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

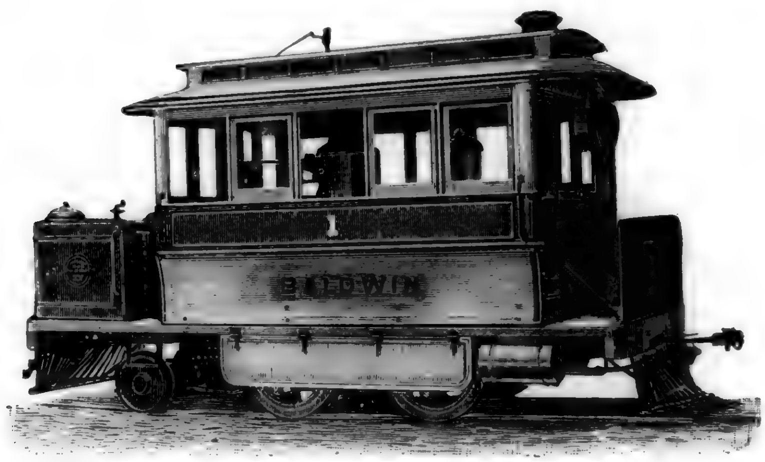
Fig. 435.



FORNEY LOCOMOTIVE FOR THE NEW YORK ELEVATED RAILROAD.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Fig. 436.



LOCOMOTIVE FOR STREET RAILROADS.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Fig. 437.

STEAM CAR FOR STREET RAILROADS.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

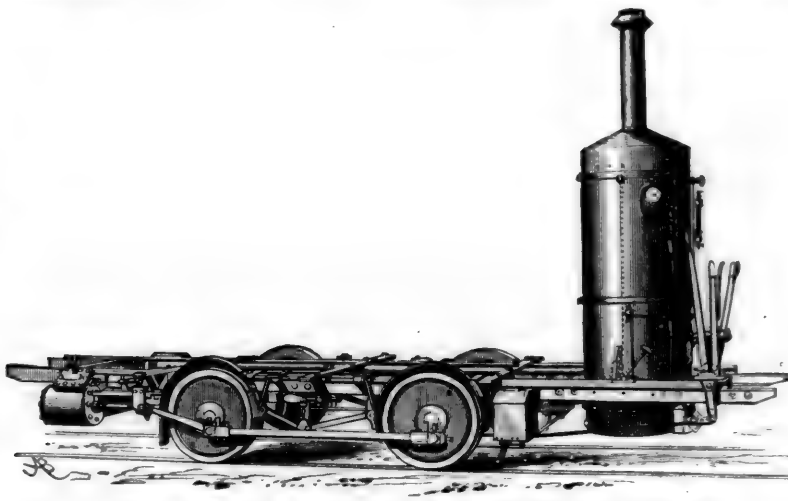
gines are used on the Hudson River Railroad in New York. The exhaust steam passes through these and then escapes into the tanks. The latter are long and narrow, so as to expose a great deal of surface to radiation, and in this way the water which becomes heated by the steam is cooled. The engines have four driving-wheels and vertical boilers. The cylinders are connected to a crank shaft with a pinion on it, which gears with another wheel of larger size on the driving-axle. In this way the speed is reduced, and great tractive power can be exerted. The whole of the engine is enclosed so as to hide the machinery, the sight of which is supposed to frighten horses. The engines were designed and patented by Mr. A. F. Smith, formerly Master Mechanic of that road.

by the truck. The load on the driving-wheels is therefore constant.

When larger engines are required and more water must be carried a four-wheeled truck is placed under the back end of the engine, as shown on page 332. This form of engine was first designed and patented by the Author, which must account for his name being coupled to it.

The late William S. Hudson designed and built a number of engines like that shown at the top of page 135. These each had a four-wheeled truck at the back end and a pony truck at the front. A similar engine, with three pairs of driving-wheels, and another with a six-wheeled truck at the back end and a four-wheeled truck in front are shown on page 134.

Fig. 438.

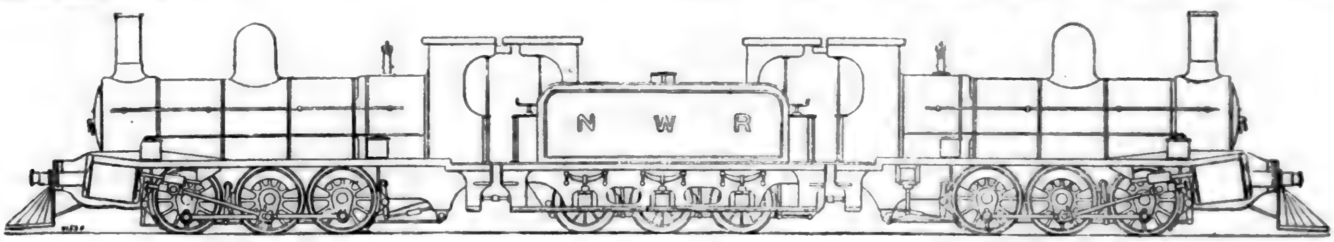


ENGINE FOR STEAM CAR FOR STREET RAILROADS.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

For roads in cities on which passengers almost exclusively are carried, an entirely different class of locomotives is needed. To suit passengers it is, of course, necessary to run a great many trains at very short intervals. When this is done the trains are necessarily very light, and therefore only light locomotives are needed. Fig. 435 represents one of the engines used on the New York Elevated Railroad. These run both ways, and through curves of only 90 ft. radius. Engines similar to that shown at the foot of page 89 are also used on this road.

QUESTION 759. *What kinds of locomotives are used for metropolitan and suburban railroads?*



Answer. The ordinary American eight-wheeled locomotive is used, perhaps, more than any other kind; but a number of locomotives, like that represented at the top of page 89, have been built and are used for this traffic. These have one pair of driving-wheels in front of the main pair, and a Bissell truck in front of the cylinder. With this arrangement the driving-wheels bear a larger proportion of weight than they do if arranged on the ordinary American plan with a four-wheeled truck. Another plan is that shown at the foot of page 135. Such engines, it will be seen, have a Bissell truck at each end, and therefore they run equally well either way. The water and fuel is carried in a separate tender. In some cases the tanks of such engines are carried on the top and sides of the boiler, as shown in fig. 434. When they are obliged to run only a short distance, and a small supply of water is needed, this arrangement answers very well; but it is impossible to carry a large supply of water in this way without overloading the wheels of the locomotive, and at the same time increasing the evils of a varying load on the driving wheels.

To get over this difficulty, and at the same time dispense with a tender, the frames are extended behind the fire-box, as shown at the foot of page 89, and the water-tank is placed on top of this extension of the frames, and its weight is carried on a pony truck below the frames and behind the fire-box. With this arrangement the whole weight of the boiler and the machinery is kept on the driving-wheels, and the water and fuel is carried

QUESTION 760. *What kinds of locomotives are used on street railroads?*

Answer. Fig. 436 represents a locomotive which is used on street and suburban railroads. Its construction is similar to that of the engine shown at the foot of page 89, but it is enclosed with a large cab, so that the working parts are not exposed. This is done to prevent horses from being frightened.

Fig. 437 represents a steam car for street railroads, and fig. 438 shows the running gear and engine without the car body. In this passengers are carried in the same vehicle that contains the engine. As shown in fig. 438, the engine has a vertical boiler, and the working parts of the engines are placed below the floor of the car.

QUESTION 761. *What is a compound locomotive?*

Answer. It is a locomotive in which the steam, after it has acted on the piston of one cylinder, escapes into another and larger cylinder, in which it acts on another piston, and thus expands more than it would if confined to one cylinder. Some engines of this kind have two cylinders, one large and one small one, or a high and a low-pressure cylinder. In other cases there are two high and one low-pressure cylinder, and in still others two high and two low pressure.

QUESTION 762. *What advantage is claimed for the compound system?*

Answer. A saving of about 15 per cent. of the fuel is claimed, owing to the greater degree of expansion of the steam. Thus far such engines have been used in this country only in an experimental way, but they are now (1889) extensively used in Europe.

QUESTION 763. *What is the difference between inside and outside cylinder engines?*

Answer. In this country it is the universal practice to put the cylinders of locomotives outside of the wheels and frames, and connect the pistons to crank-pins on the outside of the wheels. In Europe, especially in England, it is more common to put the cylinders between the frames and wheels, and connect the pistons to cranks on the main driving-axle.

QUESTION 764. *What are the relative advantages and disadvantages of these methods of construction?*

Answer. It is claimed that engines with inside cylinders run steadier than those with the cylinders outside, owing to the greater leverage which the pistons of the outside cylinders exert, owing to their greater distance from the center line of the engine. This is undoubtedly true; but if locomotives are made with a long wheel-base, as they may be if one or two trucks are used, this leverage has very little influence on the steadiness of running of the engine. It is also claimed that when inside cylinders are used they are better protected from radiation and loss of heat, as they can be placed inside of the smoke-box. On the other hand, the great objection to inside cylinders is the crank-axles, which are expensive in the first place, and are subject to frequent breakage. The inside cylinders are also more or less inaccessible for making repairs, and there are limitations to their size, if they are put between the frames. Experience in this country has led to the entire disuse of inside cylinders on locomotives.

CHAPTER XXXII.

INSPECTION OF LOCOMOTIVES.

QUESTION 765. *What are the principal divisions of the work of operating or running a locomotive?*

Answer. They are:

1. Inspection and lubrication—that is, an examination of the parts to see that they are in good working order, and the application of oil to the journals and other parts subjected to wear.
2. Getting up steam and firing.
3. Setting the engine in motion and starting the locomotive and train.
4. Management while running.
5. Management in case of accident.
6. Stopping the engine and train.
7. Laying up.
8. Cleaning the engine.

QUESTION 766. *When should a locomotive be inspected?*

Answer. It should be inspected after it has finished its run, and when there is no fire in the fire-box and when the engine is cold, so that the grates, smoke-box, chimney, and other parts can be examined. The object of this inspection is to see whether any repairs are needed before the next run. The engine should again be inspected before making another run, to see whether every part is in good condition, and that the repairs, if any were needed, have been properly made.

QUESTION 767. *When the locomotive is first inspected, what should be especially observed about the boiler?*

Answer. In the first place, all new boilers should be tested by pressure before being used, and ALL boilers, whether new or old, SHOULD BE TESTED PERIODICALLY. The oftener the better. The ways of applying the pressure test are:

1. The cold-water test—that is, by filling the boiler with cold water and then forcing in an additional quantity with a force-pump so as to raise the pressure to that at which it is intended to test the boiler.

2. The warm-water test, by filling the boiler entirely full of cold water and then kindling a fire in the grate, so as to warm this water. As water expands about one twenty-fourth in rising from 60 to 212 degrees, the rise in temperature will cause a corresponding increase in pressure; boilers are also tested with warm water by forcing it into them with an injector, which receives a supply of steam from another boiler.

3. By steam pressure.

If the latter method were not so commonly used, it would seem the height of madness to test a boiler—which is neither more nor less than an attempt to explode it—in the shop where it is built or repaired, and where the results of an explosion would be more disastrous and fatal than anywhere else, in order to see whether it will explode when put into service on the line of the road. The danger of explosion is also increased at such times by hammering and caulking at leaky rivets and joints.* It would seem, therefore, very much more rational to test boilers first by hydraulic pressure. For a first test this is preferable, because cold water will leak through crevices which would be tight when the boiler is heated, so that leaks can be more surely detected with cold than with warm or hot water. It is, however, doubtless true that boilers are often strained much more by the unequal expansion of the different parts than by the actual pressure. It is therefore thought that after the hydraulic test has been applied the second or warm-water test should be used. This can be easily done, as the boiler must be filled full of water for the first test. When the boiler is subjected to the test pressure, it should be carefully examined to see whether any indications of weakness are revealed. Any material change of form or any very irregular change of pressure is indicative of weakness. The flat stayed surfaces should be carefully examined by applying a straight edge to them before and after they are subjected to pressure, to see whether they change their form materially. One of the greatest dangers and most common accidents to locomotive boilers, as has been pointed out in a previous chapter, is the breaking of stay-bolts, to detect which, a locomotive runner and master mechanic should exercise constant vigilance. While the pressure is on, the outside surface of the boiler should be thoroughly examined with slight blows of a hammer, which will often reveal a flaw in the metal or a defect in workmanship. After the hydraulic and warm-water tests have been applied, the boiler should be emptied, and the inside examined carefully to see whether any of the stays and braces have been broken or displaced by the test. After this has been done, and not until then, should steam be generated in the boiler. In making the latter test it would doubtless be more safe to employ a pressure somewhat lower than that employed with the cold and warm water.

* Wilson on Boiler Construction.

There is great diversity of opinion regarding the maximum pressure which should be employed in testing boilers. It is doubtless true that a weak boiler might be injured and thus made dangerous by subjecting it to a very severe pressure, while without such a test it would have been safe. Recent experiments have indicated, however, that in most cases the ultimate strength of material is actually increased by subjecting it to a strain which even *exceeds* the elastic limit, provided such a strain is imposed only a few times. Although no absolute rule can be given to govern all such cases, it is thought that for the hydraulic and warm-water tests, a pressure about 50 per cent. greater and for the steam test 25 per cent. greater than the maximum working pressure should be employed.

Before old boilers are tested, they should be very carefully examined, both inside and outside, to see whether they are injuriously corroded. It is to be regretted that the insides of locomotive boilers are usually made so difficult of access that it is impossible to discover the extent and the effects of corrosion without the most careful examination. This is not possible without getting inside of the boiler. Whenever this can be done, a prudent locomotive runner should use the opportunity of inspecting the boiler of his engine himself, and not depend upon the boiler-makers who are employed for that purpose. He should remember that it is his life and not theirs which is exposed to danger by any weakness or defect in the construction of the boiler of the locomotive which he runs.

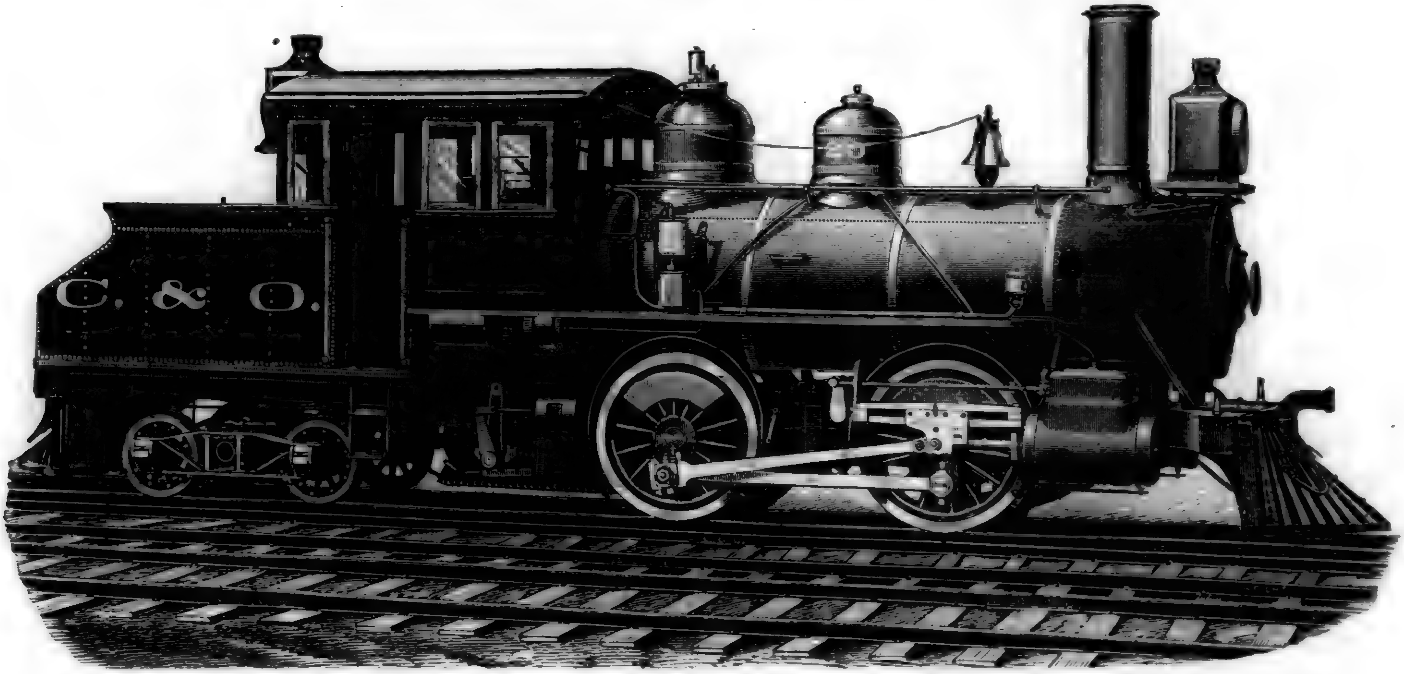
Before starting the fire in a locomotive, the fire-box should be carefully examined to see if there are any indications of leaks, which will often reveal cracked plates, defective stay-bolts or flues. If the latter simply leak at the joints, they can generally be made tight by caulking or by the use of a tube expander. This is easily done when the engine is cold, but if not attended to may be very troublesome on the road. Bran or other substances containing starch, mixed with the feed water, may stop leaks, but this is only a temporary expedient. Leaks of the boiler should always be causes for suspicion, and a leaky seam or stay-bolt may be caused by dangerous internal corrosion. A leak about the boiler head should lead to an examination, to ascertain whether any of the inside stays or braces are broken. If this occurs it may be indicated by the bulging of the plate which forms the boiler head. Leaks at other parts of the boiler should be examined, as they may reveal dangerous fractures.

It is of the utmost importance, both for safety and for economy of working, that boilers should be kept clean—that is, free from mud and incrustation. In some sections of the country, especially in the Western States, this is the greatest evil against which locomotive runners and those having the care of locomotives must contend. The cures which have been proposed are numberless, but that which is now chiefly relied upon is, first, the use of the best water that can be procured, and second, frequent and thorough washing out of the boiler.

QUESTION 768. *What sort of examination should be given to the boiler attachments?*

Answer. It should be observed whether the grate-bars or drop-doors of the grate are properly fastened, whether any of the grate-bars are broken, and whether the ashes have been cleaned out of the ash-pan, and also whether the fire is clean—that is, whether the grates are free from cinders or clinkers. The height of water in the boiler should be observed by testing it with the gauge-cocks and by noticing it in the glass gauge, if one of these is used. It is also well to blow out the sediment and mud from the glass gauge before starting, and to see that the valves which admit steam and water to the glass are open. They should, however, be opened only a very short distance, so that only a small quantity of steam or hot water will escape in case the glass tube should be broken. The injector, if one is used, should be tested to see that it is in working order, and as soon as the engine starts out of the engine house both of the

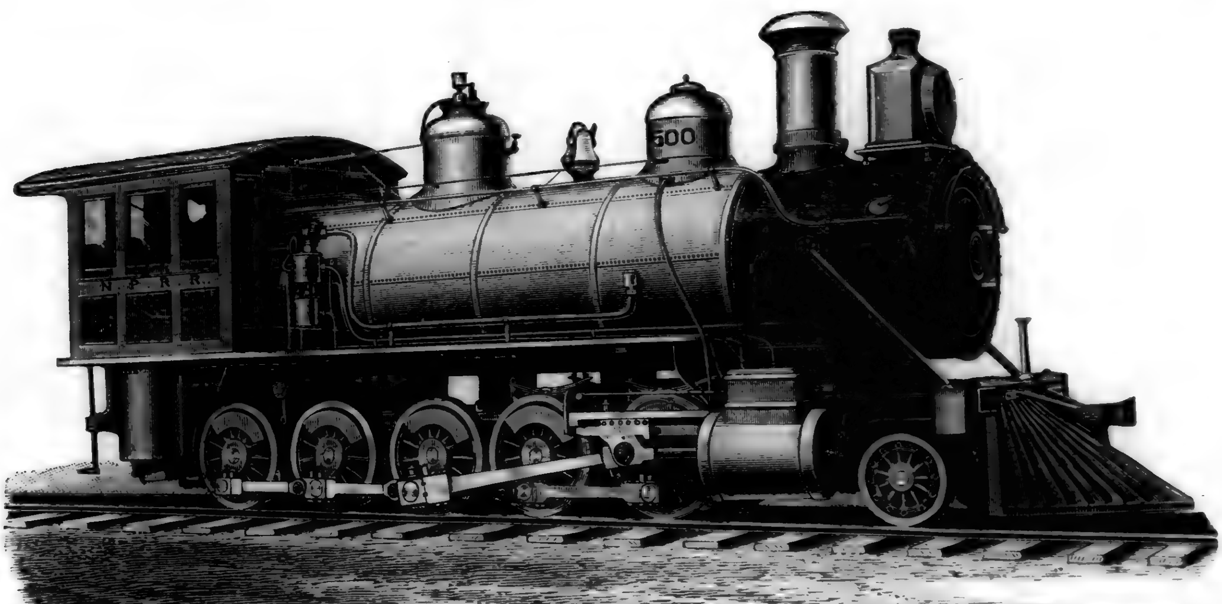
CATECHISM OF THE LOCOMOTIVE.



FORNEY LOCOMOTIVE FOR SUBURBAN TRAFFIC.

BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

Total weight in working order	110,000 lbs.
Total weight on driving-wheels	75,000 "
Diameter of driving-wheels	4 ft. 9 in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	7⅛ "
Distance from center of front to center of back driving-wheels	7 ft. 6 "
Total wheel-base of engine	23 " 7 "
Diameter of cylinders	17 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler-ring.	54 "
Length of fire-box, inside	5 ft. 0 3/16 in.
Width of fire-box, inside	2 " 10⅜ "
Depth of fire-box, crown-sheet to top of grate	5 " 6 "
Number of tubes	187
Outside diameter of tubes	2 in.
Length of tubes	11 ft. 6 "
Grate surface	14.3 sq. ft.
Heating surface, fire-box	127.8 " "
Heating surface, tubes	1,116.9 sq. ft.
Heating surface, total	1,244.7 " "
Exhaust nozzles	Single.
Size of steam-ports	16×1⅛ in.
Size of exhaust-ports	16×2½ "
Throw of eccentrics	5¼ "
Greatest travel of valve	5⅜ "
Outside lap of valve	0⅝ "
Smallest inside diameter of chimney	1 ft. 6 "
Height, top of rail to top of chimney	14 " 4 "
Height, top of rail to center of boiler	6 " 8 "
Water capacity of tank	1,500 gals.
Coal capacity	6,000 lbs.



DECAPOD LOCOMOTIVE.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Total weight in working order	148,000 lbs.
Total weight on driving-wheels	123,000 "
Diameter of driving-wheels	3 ft. 9 in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	8 "
Length of main driving-axle journal	9 "
Distance from center of front to center of back driving-wheels	17 ft. 0 "
Total wheel-base of engine	24 " 4 "
Total wheel-base of engine and tender.	49 " 2 "
Diameter of cylinders	22 "
Stroke of cylinders	26 "
Outside diameter of smallest boiler ring	5 ft. [illegible] in.
Length of fire-box, inside	10 " 1¼ "
Width of fire-box, inside	3 " 6⅝ "
Depth of fire-box, crown-sheet to top of grate	4 " 6½ "
Number of tubes	270
Outside diameter of tubes	2¼ in.
Length of tubes	13 ft. 6 "
Grate surface	36 sq. ft.
Heating surface, fire-box	162 " "
Heating surface, tubes	2,148 " "
Heating surface, total	2,310 " "
Exhaust nozzles	Double.
Size of steam-ports	16×1⅜ in.
Size of exhaust-ports	16×3 "
Throw of eccentrics	5 "
Greatest travel of valve	5⅜ "
Outside lap of valve	0⅝ "
Smallest inside diameter of chimney	1 ft. 8 "
Height, top of rail to top of chimney	14 " 6 "
Height, top of rail to center of boiler	7 " 3⅛ "
Water capacity of tender tank	3,600 gals.

pumps—if there are any—should also be tested, in order to see whether they are in good working condition. The safety-valves should be raised, so as to be sure that they are not rusted or otherwise fastened to their seats. There is no part of a locomotive more liable to disorder than the steam gauge. For this reason it should be frequently tested, and whenever there is any indication of irregularity in its action it should be examined. As the wire netting on the smoke stack often has holes cut into it by the action of the sparks, it should be frequently examined to see whether it is in good condition. It is also liable to be "gummed up," especially if too much oil is used in lubricating the cylinders and valves. As soon as holes are cut into the netting there is danger that the sparks which escape will set fire to the combustible material near the track, and if the netting is gummed up the draft will be obstructed and the engine will not make steam. The gummy matter can often be removed by building a fire on top of the netting. In this way the oil in the gummy matter is burned up, which leaves a dry material which can then, at least to some extent, be beaten out of the netting.

The smoke-box door should be opened occasionally to see whether the petticoat-pipe, deflecting plates, and wire netting are in good condition and properly secured, as a failure of any of these parts when the engine is on the road is very annoying and is liable to cause much delay. If there is any suspicion that the steam pipes leak, the throttle-valve should be opened slightly, so as to give the engine steam while the smoke-box door is open. The leak will then be indicated by the escaping steam. The smoke-box should be kept clear of ashes and cinders.

QUESTION 769. *What should be noticed in connection with the throttle-valve?*

Answer. As a failure of the throttle valve to work may be the cause of a most serious accident, it should be certain that it is in good working condition, that all the bolts, pins, and screws and other accessories are in good working order. It should also be known whether the throttle-valve is steam-tight. This can be learned by observing whether steam escapes from the exhaust-pipes or cylinder-cocks when the latter are open, the reverse lever in full gear, and the throttle-valve closed. If the throttle-valve leaks, enough steam may accumulate in the cylinder, when there is no one on the engine, to start it, and in this way cause a serious accident. The throttle lever should always be fastened with a set-screw or latch of some kind when the engine is standing still.

QUESTION 770. *In inspecting the cylinders, pistons, guides, and connecting-rods, to what points should the attention be directed?*

Answer. It should be known whether the piston packing is properly set out—that is, whether it is so tight that it will not "*blow through*," or leak steam from one end of the cylinder to the other, which of course will waste a great deal of steam. Of the two evils, it is, however, better to have piston-packing too loose than too tight, because if it is too tight, it is liable to cut or scratch the cylinders so as to make it necessary to rebore them, and at the same time if the packing-rings are lined with Babbitt metal, the heat created by the intense pressure and friction will melt the metal. In some cases the cylinders become heated to so high a temperature from this cause that the wood-lagging with which they are covered on the outside is burned.

The packing of the piston-rods should be steam-tight, and it should be observed whether the rod and the pump-plunger are securely attached to the cross-head.

The utmost care must be exercised to keep the guides well oiled. The oil cups on the guide-rods or cross-heads, when they are placed on the latter, must be kept clean, so that the oil will flow freely, and yet not too rapidly, on the surfaces exposed to friction. The same thing is true of the oil-cups on the connecting-rods. Attention should be given to the brass bearings of the connecting-rods to see that they are not so loose as to thump, nor keyed so tight on the crank as to be liable to heat. The latter can be easily known by moving the stub-end lengthwise of the journal. They should never be so tight that they cannot be thus moved with the hand. Especial attention should be given to seeing that all the bolts and nuts on the connecting-rods are tight. There are no parts of a locomotive which require more careful attention in order to keep them lubricated, and thus prevent them from heating and being "cut," than the bearings on the crank-pins and the slides of the cross-head. Examination should be made to see that neither the piston-rods, pump-plungers, guides, connecting-rods, nor crank-pins are bent or sprung.

QUESTION 771. *How can it be known whether the piston-packing is too loose or "blows through?"*

Answer. It can usually be noticed in the sound of the exhaust, which can be heard very distinctly on the foot-board when the furnace door is opened. If the packing is not tight, it produces a peculiar wheezing sound between and after each discharge of steam. If the packing leaks, it will also be indicated by the escape of steam from *both* the cylinder-cocks, if they are open, just after the crank passes the dead point. This will usually show in which of the cylinders the packing is too loose. The same thing will occur, however, if either or both of the main valves leak, so that it is often hard to determine whether the "blow" is due to a leak from the valve or from the piston. Of course, it may sometimes happen that both leak, or that the piston on one side and the valve on the other leak, so that often the diagnosis of the disease, as the doctors say, is extremely difficult. Careful observation and experience will, however, aid a locomotive runner in detecting such defects much more than any directions which can be given here.

QUESTION 772. *What is meant by "setting out packing," and how should it be done?*

Answer. "Setting out packing" is simply expanding the rings when they get too loose. With ordinary spring packing, figs. 182 and 183, which is now generally used, this is done by screwing up the nuts *b*, *b*, *b*, which, as was explained in answer to Question 309, compresses the springs *a*, *a*, *a*, and thus expands the rings *A*, *A*. In doing this, as already stated, great care must be exercised not to screw the nuts up too hard, and it is always better to have the packing too loose than too tight. Care must also be taken to keep the piston-rod in the center of the cylinder, otherwise there will be undue pressure and wear on the stuffing-box. After the nuts are screwed up, the position of the piston-head should be tested with a pair of callipers. This is done by placing one leg of the callipers against the side of the cylinder, and setting them so that the other leg will just touch the edge of the projection *C*, fig. 183, or the end of the piston-rod. Then by placing the callipers above and below, and on each side of the piston, it will appear whether it is too high or too low or too near either side. If the piston is not in the middle of the cylinder, by loosening the nuts on one side and tightening them on the other it can be moved to a central position. Ordinarily this work is intrusted to persons who are employed for the purpose. A young locomotive runner, fireman, or mechanic will, however, always do well to familiarize himself with such duties, and, if possible, do it himself, under the direction of those who are skilled in that kind of work.

QUESTION 773. *If the stuffing-box of the piston-rod leaks, what should be done?*

Answer. If it is packed with fibrous packing and it is in good condition, it can usually be made tight by simply screwing up the nuts on the gland. In doing this, they should not be screwed up more than is necessary to make the packing steam-tight. Any greater pressure only increases the friction on the piston-rod unnecessarily. The two bolts should be screwed up equally, otherwise the gland will be "canted—" that is, inclined so as to "bind" or bear unequally and very hard against the piston-rod, and thus be liable to cut or scratch it. After packing has been in the stuffing-box a long time, it becomes very hard and compact, and sometimes partly charred. Then either it must be removed and new packing be put in, or, if in tolerably good condition, it can often be made to work well by simply reversing it—that is, by putting that which was at the bottom of the stuffing-box on top and *vice versa*. Before packing is put into a stuffing-box, the former should always be thoroughly oiled.

QUESTION 774. *When the slides of the cross-heads wear, how is the lost motion taken up?*

Answer. When there are gibs on the cross-head, the lost motion can be taken up by putting "*liners*" or "*shims*"—that is, thin pieces of metal, between them and the cross-head, so that they will fill up the space between the guide-bars. When there are no gibs, the guide-bars must be taken down, and the blocks between them at each end must be reduced in thickness so as to bring the bars nearer together. In doing this, great care must be taken that the guides are accurately "in line" with the center line or axis of the cylinder. This work should never be intrusted to any excepting skilled workmen, from whom those who are inexperienced should seek instruction.

QUESTION 775. *When the brass bearings of the connecting-rods become too loose on their journals, what should be done?*

Answer. They must be taken down, and the two surfaces in contact must be filed away so as to bring them closer together. In doing this they must be filed square with the other surfaces, otherwise they will not bear equally on the journals when they are keyed up. Before attaching them permanently to the rods, they should be keyed on the journal in the strap alone, so that it can be known by trial whether they move freely and yet are tight enough to prevent thumping on the journal. When they are attached to the rod, it is very important, especially with coupling or parallel-rods, that the correct length from center to center of the bearings be maintained. It is much better to leave coupling-rods loose on their journals, because, if the bearings are keyed up tight, the rods are sure to throw an

enormous strain on the crank-pins, as the distance between the centers of the axles is not always absolutely the same, owing to the rise and fall of the axle-boxes in the jaws. It is therefore always best to have a little play in the coupling-rods, and it is safe to say that much more mischief is done by meddling with the coupling-rod brasses than by neglecting them.

QUESTION 776. *What should a locomotive runner observe in making an inspection of his locomotive?*

Answer. A good locomotive runner will always give ample time for the inspection of his engine before starting out. It is assumed that the inspection which has been described has been made after the engine has completed a trip, and when there is no fire in the fire-box. Before starting a careful locomotive runner should begin at the front of his engine and see that the

PILOT

and all its fastenings are in good condition. He should be especially alert in inspecting this, as well as all other parts of the locomotive, to see that

BOLTS AND NUTS

have not been lost, and are screwed up tight, and that the

KEYS

are all right. If any part of his run is made after dark he should examine the

HEAD-LIGHT,

to see that it has been properly filled and trimmed and is in good condition, and also that the

SAND-BOX

has been filled. All the

WHEELS

of the engine and tender should be carefully examined, to see that they are sound. A fracture in a driving-wheel is usually apparent if the wheel is carefully examined. The condition of ordinary cast-iron tender and truck-wheels is revealed on striking them with a hammer, when if they are sound they will give out a peculiar clear ring; whereas if they are fractured, the sound produced by the blow of the hammer may be dead, like that of a cracked bell.

An inspector should not rely entirely on this test, as broken wheels will sometimes give a clear ring. He should examine them carefully for cracks or other fractures, and should see that the flanges are not broken, as this may occur and not be revealed by the sound produced by a blow from a hammer. If any of the flanges of the wheels are unduly worn the fact should be reported to the proper person. The wearing of flanges is due to a variety of causes which are sometimes difficult to discover, such as the difference in the diameters of the wheels or the hardness of the tires in the same axle; axles not parallel or the truck "out of square," center-plate or pin not in the center of truck, bent axles or malformation of rails are some of the causes which produce sharp flanges. The

STEEL TIRES

of both the driving and the truck-wheels should be examined for flaws and broken flanges, and to see whether they have worked loose on the wheel centers. Moisture and dirt issuing from between the tire and wheel indicates that the former is becoming loose, which is more liable to occur when the tires are worn thin than before. The

AXLES

too should be examined to see that the wheels have not worked loose on the wheel-seat. When this occurs it often becomes apparent by the oil from the axle-boxes working through between the hubs of the wheel and the axle. This can be observed on the outside of the wheels when the bearings are inside, and inside the wheels when the bearing is outside. The

SPRINGS

should be examined, to see that they are in good condition, and the oil holes in the boxes must be kept clear, so that the oil can reach the bearings. The

TENDER AND ENGINE TRUCK-BOXES

are kept oiled by packing them with cotton or woolen waste saturated with oil. This should be taken out occasionally and renewed and the boxes cleaned. The working of the

DRIVING BOXES

up and down the jaws will in time wear them so that there will be some lost motion in the jaws. This will be indicated by a thump when the cranks pass the dead point. A similar thump will, however, be produced by lost motion in the boxes of the main connecting-rod, so that it is difficult to determine, without special examination, the cause which produces the concussion. It is therefore best when an engine works with a thump at each revolution for the runner to stand by the side of it where he can touch the connecting-rods and driving-wheels, and then have the fireman open the throttle-valve, so as to move the engine slowly. If the lost motion is in the connecting-rods it can be felt by the jar as it passes the dead points. The same is true of lost motion in the jaws, which can be felt by touching the driving-wheels. When the jaws become worn the lost motion can be taken up by moving up one or both of the wedges. When this is done, great care must be taken to keep the centers of the driving-axles the same distance apart on both sides of the engine, and also to keep their center lines square with the frames. In the best designed locomotives the driving-boxes now have only one wedge, which is usually on the back side of the box, as shown in fig. 286. The frame in front of the box is protected by a straight shoe or by a wedge the full length of the jaw so that it cannot be moved up or down. This is done so that the position of the box cannot be changed by carelessly or ignorantly moving one wedge up and the other down. There should always be center-punch marks placed on the frames or guide-yokes on each side of the engine in front of the main axle, and at equal distances from its centers, so that when the boxes or jaws become worn the position of the axle can be adjusted with a tram from these marks. Of course, if the main axle is square, it is easy to adjust the trailing axle from it with a tram. If the axles are not square with the frames and parallel with each other, the engine will run toward one side or the other of the track, according to the inclination of the axles. It sometimes happens that the bolts which hold up the wedges in the jaws are broken. When this occurs the wedge drops down, and of course the box has so much lost motion that it soon manifests itself in the working of the engine. These bolts, and also those which hold up the clamps on the frames at the bottom of the jaws, should be examined when the engine is inspected, so as to be sure they are in good condition.

The engine and tender should occasionally be lifted up from the

CENTER-PLATES

of the trucks, and the plates should be lubricated with tallow. It often happens that these become dry, so that they are difficult to turn when the weight rests on them, and therefore they will not adjust themselves easily to the curves of the track.

QUESTION 777. *What part of the valve-gear should receive attention when the engine is inspected?*

Answer. All the bolts, nuts, and keys should be carefully examined to see that they are properly fastened. The bolts and nuts in the eccentric straps are especially liable to become loose, and as they are between the wheels, and therefore not easy of access, are often neglected. The oil-holes should all be seen to be clear, otherwise it will be impossible to keep the journals well oiled. The eccentric straps and the link blocks are very liable to be imperfectly oiled, and when the former become dry and cut, they throw a great strain on the eccentric-rods, which is liable to break them. When this occurs the strap and the portion of the rod which is attached to it revolve with the eccentric, and frequently a hole is thus knocked into the front of the fire-box, which disables the engine. The valve gear is, with the exception, perhaps, of the pumps and injector, the most delicate part of the locomotive, and more liable to get out of order than any other, and should therefore be watched with the greatest care.

QUESTION 778. *How can it be known whether the main valves of a locomotive are tight?*

Answer. As already indicated, the symptoms which manifest themselves when a valve leaks are very similar to those which appear when the piston packing leaks. If the valve is moved to its middle position and steam is admitted into the steam-chest, and it then escapes from both cylinder-cocks, it is apparent that the valve is not tight. But the valve faces of locomotives usually wear concave, because the valves are worked most about half-stroke, so that they will often be tight when in the center of the face, but will leak at the ends of the full stroke. This will become apparent by the peculiar wheezing sound, already referred to, when the engine is at work. As has been explained, it is, however, often very difficult to determine whether this sound is due to a leak at the pistons or the valves. If the packing of the valve-stem leaks, it can be remedied in the manner described for making that of the piston-rod tight.

QUESTION 779. *What other parts of a locomotive should be examined before starting?*

Answer. It should be certain that the brakes on the tender are in good working condition—that is, that the bolts, nuts, and keys are all secure, the levers, rods, and chains properly connected, and the shoes fastened and not too much worn. If

either an atmospheric or vacuum brake is used, it should be tested before starting, as was fully explained in Chapter XXVI.

The inside of the water-tank should also be examined occasionally, to see whether it is clean, and if not it should be thoroughly washed out. If the tank is new or has had any repairs done to it, the inside should be carefully examined to see whether any waste rags or other objects have been left in it, as these might obstruct the strainers over the water-supply pipes. The strainers should be examined occasionally to see whether they are clear. The man-hole of the tank should always be covered, excepting while taking water, so as to exclude cinders and coal, which are liable to obstruct the pump valves. It is hardly necessary to say that it must always be certain before starting that there is enough water in the tank to feed the boiler until the next point is reached at which a supply can be obtained. The sand-box must also be filled, the bell rope in good condition, and if running at night the reflector of the head-light must be polished and the lamp supplied with oil and the wick trimmed so as to burn brilliantly. The locomotive runner must also see that the proper signals are displayed in front of his engine.

QUESTION 780. *What tools, etc., should every locomotive runner on the road carry?*

Answer. A coal shovel, coal pick, long-handled hoe* and poker, a pair of jacks—either screw or hydraulic, chains, rope and twine to be used in case of accident, a heavy pinch-bar for moving the engine, a small crow-bar, oil-cans with short and long spouts and another smaller one with spring bottom, a steel and a copper hammer, a cold and a cape chisel, a hand-saw, axe and hatchet, one large and one small monkev-wrench and a full assortment of solid wrenches for the bolts and nuts of the engine, cast-iron plugs for plugging tubes, with a bar for inserting them, two sheet-iron pails or buckets, different colored lanterns and flags, according to the colors used for signals on the line, and a box with a half dozen torpedoes.

QUESTION 781. *What duplicate parts should be carried with the engine?*

Answer. Keys, bolts, and nuts for connecting-rods, split-keys, wedge bolts, bolts for oil-cellars of driving and truck-boxes, driving and truck spring-hangers, wooden blocks for fastening guides in case of accident, blocks for driving-boxes and links, a half dozen ¾-in. bolts, from six inches to two feet long, to be used in case of accident, two extra water-gauge glasses, two glass head-light chimneys.

QUESTION 782. *What should be observed in lubricating a locomotive or any other machinery?*

Answer. The most important thing to observe is that the oil reaches the surface to be lubricated. It is of much greater importance that the lubricant should reach the right place than that a large quantity should be used. A few drops carefully introduced on a journal will do much more good than a large quantity poured on the part carelessly. For this reason all oil-cups and oil-holes should be kept clean so as to form a free passage for the oil. It should also be remembered that no automatic oil-cup will work satisfactorily a great while unless it receives the attention which all of them require.

The following directions have been given by the manufacturers for the care of the sight feed lubricators, illustrated and described in Chapter XXIX. :

DIRECTIONS FOR USING THE NATHAN SIGHT-FEED LUBRICATOR.

"Fill the cup with clean, strained oil through the filling plug *A*, then open the water-valve *D*.

"To start: Open the steam-valve *B*, wait until the sight-feed glasses have filled with condensed water, then regulate the feed by the valves *C C*. To stop: Close the valves *C C*.

"To renew the supply of oil: Close the valves *C* and *D*, and draw off the water at the waste-cock *E*; then fill the cup and start again as before, always opening the valve *D* first.

"The valves *F F* must be always kept open, except when one of the glasses breaks. In such case close the valves *F D* and *B*, to shut off the cup, and use the auxiliary oilers *O O* as common cab oilers.

"The valve *D* must be closed or opened in advance of the valve *B*, whenever this latter is closed or opened.

"Once in two weeks at least blow out the cup with steam, opening the valves wide, with the exception of the filling plug *A*, which should remain closed."

In inspecting a locomotive, it should be observed whether the oil-cups are screwed down tight to the part to which they are attached. They are liable to work loose and be lost, or by getting between some of the working parts, to cause a breakdown.

QUESTION 783. *What precaution should be taken if any repairs have been done to the engine?*

Answer. The parts which have been repaired should be examined carefully to see that they have been properly done, and if they require lubrication, it should receive especial attention, as new parts are always liable to heat or cut.

QUESTION 784. *In the examination, care of, and repairs to injectors what precautions should be observed?*

Answer. 1. The pipe connections should be kept perfectly tight to prevent air leaks.

2. The steam-valves should be kept tight to prevent escaping steam from heating the suction-pipe, which interferes with the formation of a vacuum and prevents the instrument from lifting the water.

3. The packing of the different spindles and valve-stems to be kept in good condition, so that they will be steam or air-tight.

4. The nozzles of the injector must be taken out and thoroughly cleaned more or less often—according to the character of the water used—so as to keep them as far as possible free from incrustation. Mineral oil drawn with the water, when the injector is at work, will have an excellent effect in keeping it free from scale. Some injectors are arranged to receive an oil-cup for this purpose.

5. The boiler check-valves must be kept tight and free from dirt and incrustation, to prevent the back-flow of hot water and the sticking of the valves.

QUESTION 785. *If a lifting injector is tested and does not lift the water properly, to what causes may it be due?*

Answer. It may be due:

1. To a leak in the steam-valve, and the consequent heating of the suction-pipe to such a degree as to prevent the formation of sufficient vacuum in that pipe. This defect can be remedied only by grinding the steam-valves, so as to make them tight. Such a leak will be indicated by an escape of steam from the overflow when the steam-valves are closed.

2. To a leak in the suction-pipe or its connection, in which case the air drawn in by applying the lifting jet will prevent the formation of the vacuum. Such a leak can be detected by closing the heater-cock and opening the main steam-valve only—if there is a separate lifting jet—or, with a single lever instrument, by opening both steam-valves at once. The steam blowing back to the tank will then escape through the leak, if there is one. The trouble will usually be remedied by tightening up the suction pipe connections.

3. To a leak in the boiler check-valves and the consequent heating of the suction-pipe by the hot water from the boiler flowing back through the injector. Grinding the check-valve will remedy this.

QUESTION 786. *If the injector lifts the water, but does not take it up and throw it out through the overflow, or the stream flowing into the boiler breaks, to what causes may it be due?*

Answer. 1. To a slight leak in the suction-pipe, not sufficient to prevent a short lift, but enough so that the air drawn in disturbs the current in the nozzles. Such a leak can be detected and remedied as explained in answer to the previous question.

2. To obstructions in the suction-pipe, floating matter, bits of wood, hemp, leaves, obstructions in the strainer, or not sufficiently large strainer to admit the proper supply of water. If the strainer is obstructed it must be taken out and cleaned. The present strainers in general use, consisting of a perforated cone inside of the suction-pipe, are a frequent cause of trouble in the working of injectors. They are usually not large enough and difficult of access for cleaning. The suction-pipe itself can be cleaned by blowing steam through it with the heater cock closed.

3. To boiler check-valves sticking fast, on account of corrosive incrustation, or dirt in the valve-chamber, which prevents the free action of the valves. The remedy is to open the valve-chamber, and thoroughly clean the valve, its seat, and guides.

4. To leaky heater-cock check, which will be indicated by a sputtering sound, which is again caused by the air taken in through the overflow. Grinding the check will remedy it.

Manufactures.

The Griggs Electric Air Signal.

THE accompanying illustrations show a system of communication between train and engine intended to replace the bell-cord. This device is the invention of Mr. G. M. Griggs, and is made by the Griggs Electric Air Signal Company, of Wilmington, Del.; it has been submitted to a very full trial on the Wilmington & Northern Railroad, with very satisfactory results.

The system is operated by opening and closing a small plunger-valve by an improved electro-magnet, the valve sup-

* These are of course not needed on wood-burning engines.

plying air for the blowing of a miniature whistle, the time and duration of the blast being governed by the conductor at will.

The magnet valve and box are shown in fig. 1 sufficiently to dispense almost with any explanation. The dotted lines on the valve exterior show the air passages, valve and seat. The magnet has a peculiar feature, as shown, which is new. Instead of an ordinary flush face, the core is made with lopping ears rising at a slight angle, the purpose of which is to decrease the traverse of the magnetic field, and bring the armature within very close play of the iron, at the same time giving all the needed travel to open the valve at the smaller lever end. The advantage in this is to greatly increase the efficiency of the system, as the magnetic field decreases as the square of the distance increases between armature and magnet core. The wires at the bottom of the box are the terminals of the magnet.

The coupling, fig. 2, is of the plunger type, made of hard rubber and spring brass; it is in shape to meet the very rigorous requirements made of it, as it is swung underneath the platform and subjected to flying dust, dirt, and moisture. The plungers are made pene-headed, and operated as shown in the section. By reason of the pene-head expanding in the interior of the female end, it is kept constantly bright by the compression in

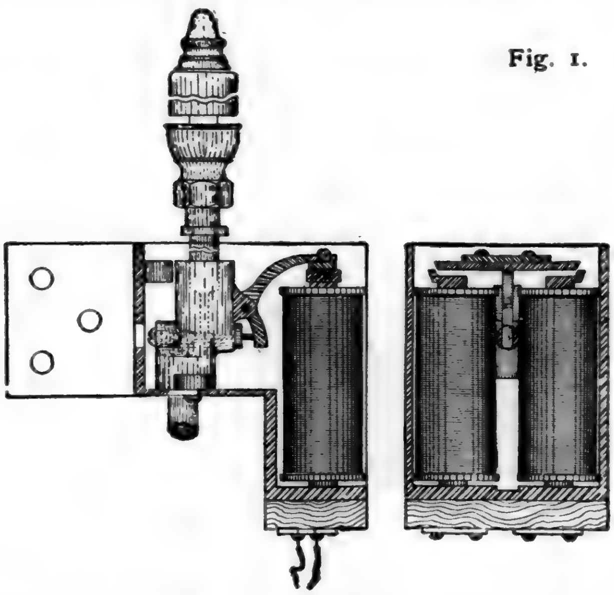


Fig. 1.

making and breaking contact. This is a necessary element, and this coupler, it is said, has shown itself capable of insuring good contact at all times. The interior pin has a tongue fastened to it, as shown, which joins the overlapping ears when the coupling is made and broken. This automatically makes contact when so doing, and blows the signal. This occurs either when the coupling is pulled apart violently by the breaking of the car-coupler, or, in making up a train, notifying the engineer to try his air.

The contact pull, fig. 3, is placed over the door, connected at one end by a cord which runs to the rear end of the coach and by a short end to the hood in front; pulling either end dips the plunger in against the contacts and closes the circuit across, making a multiple connection with the line underneath the coach with which it is connected. The connecting wires pass up through the water-closet. By reason of the metallic springs rubbing against the plunger, the ends of the same are kept constantly bright and in operative condition.

The battery is of the Gassner type of dry battery, which has been tried in this connection for four months, accurate meas-

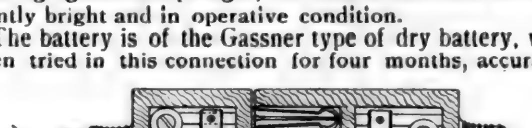


Fig. 2.

urements being taken at different intervals, and no deterioration in the output of the same being found in the trial. The eight cells are worked through a resistance of 27 Ohms, insuring a long life. The Company agrees to guarantee this battery for two years intact, and it can be recharged at the end of that period. It is placed in a tray-box under the running-board on the engineer's side, and spring contact with the line is made automatically in placing the tray in position. A dry battery is considered superior to a wet one, owing to the amount of oscillation and shake to which it is subjected in its position.

Facing the platform the connection of the wires is placed to the left of the drawhead, which position leads the couplings across the air-hose at right angles. The wiring runs from thence to the left cell for the entire length of the coach; it is covered and lagged and thoroughly protected from the weather and any ill usage to which it would necessarily be exposed by being hung in suspension or held by cleats to the car underneath.

Manufacturing Notes.

THE Bucyrus Foundry & Manufacturing Company has removed its Chicago office from its former location at 115 Dearborn Street to Room 656 in "The Rookery," corner La Salle and Adams streets. This office is under the management of Mr. E. W. Cramer, who represents both this Company and the Bucyrus Steam Shovel & Dredge Company, in Chicago and vicinity.

IN issuing a sketch showing the standard flange and tread, Messrs. Thomas Prosser & Son, representatives of the Krupp Works, say: "Unless otherwise requested, we will in future

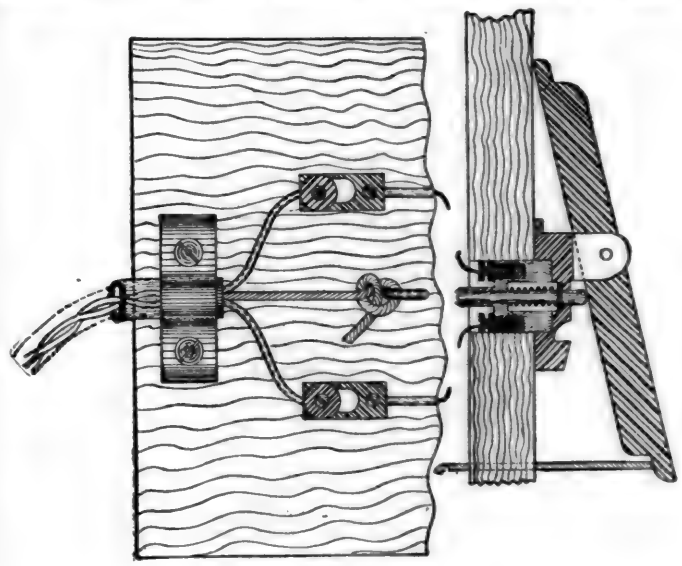


Fig. 3.

furnish all locomotive driving-wheel tires, leading locomotive truck wheels, tender wheels, and car-wheels, with the flange and tread shown on sketch enclosed, as it seems to be the general disposition of railroad officials to adopt this flange and tread as a standard, and most of the orders we have lately received specify same.

"A few months ago we had on file between 75 and 100 different styles of flanges and treads, and are pleased to report that hardly without an exception the parties using them have notified us that they have adopted as a standard the flange and tread adopted by the Master Mechanics' and Master Car-Builders' Associations, and it is hoped it will be made the 'Standard' in every sense of the word."

THE Acme Machinery Company, Cleveland, O., has recently added to its works an erecting shop 50 × 120 ft., and two stories high, and also a three-story building containing offices, drawing-room, and tool-room. In the erecting shop there is a five-ton traveling crane, built by the Brown Hoisting & Conveying Machine Company. The Company recently shipped five 5-in. bolt-cutters and one 6-in. bolt-cutter, one of the largest orders of the kind ever filled.

THE Baldwin Locomotive Works has just ended negotiations with the Roanoke Rolling Mill, of Roanoke, Va., for the purchase of 200 tons of bar iron. The price at which the sale was conducted is not given, but it is understood to be below the price ruling for Pennsylvania iron. This sale is said to be the first transaction in Southern manufactured iron consummated in this State.—*Philadelphia Inquirer.*

THE Westinghouse Machine Company, Pittsburgh, Pa., is fitting up a new machine shop for large work. A very large new planer, by William Sellers & Company, is already erected and in operation, and a large new cylinder boring-machine, of special design, by the Pond Machine Tool Company, is now in process of construction. Other large tools will be added. The new shop is rendered necessary by the Company's heavy run of orders for large compound engines. These include several of 200 and 250 H.P. from the Southern Cotton Oil Company, the

Baldwin Locomotive Works, and other parties. The Company has recently sold smaller engines for electric lighting plants in Havana, Cuba, and Madrid and Barcelona, Spain.

The Goodwin Dump-Car.

THE accompanying illustrations show an improved form of the Goodwin dump-car. The improvements are covered by Patent No. 403,584, dated May 21, 1889, and issued to John M. Goodwin, of Sharpsville, Pa. The improvements include a detent for the valves of dump-cars, designed particularly for use in the Goodwin car, but applicable to any car having swinging valves extending lengthwise of the cargo-box. The patent

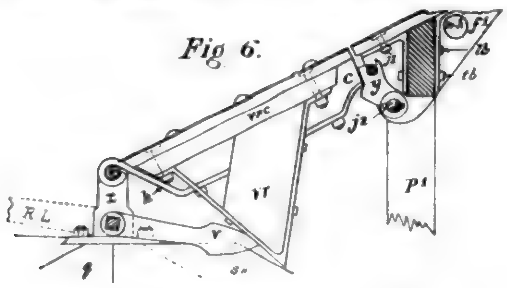


Fig. 6.

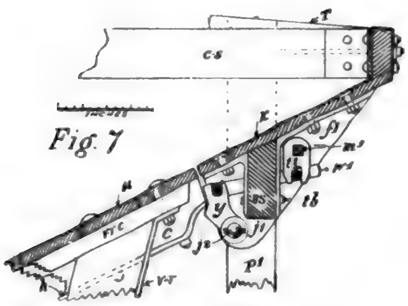


Fig. 7.

covers, also, improved appliances for replacing the valves of the Goodwin dump and adjustable side-boards, by the use of which the car is, on occasion, rendered entirely available for ditching service, or any work in which the loading of a car by hand-shoveling from alongside the track is necessary. The top of the side-board is not as high above the rail as the floor of an ordinary flat car. With the side-boards in use the car dumps (all on one side or half on each side) in the same way as when loaded from chute or by steam-shovel.

In the illustrations, fig. 2 is a cross-section of the car (of four-wheeled form), showing the disposition of parts for dumping entire load on the side *D*. The adjustable side-board on side *U* is shown merely for the purpose of illustrating the mode of attaching such board, for use in case the loading of the car from the ditch, by hand-shoveling, is desired.

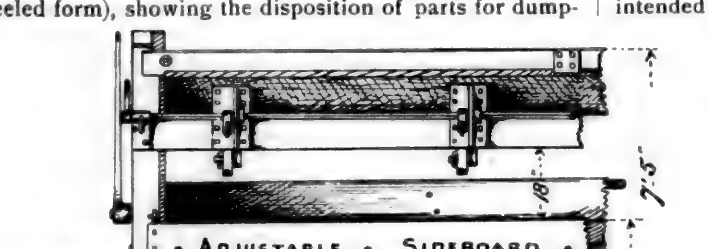


Fig. 8.

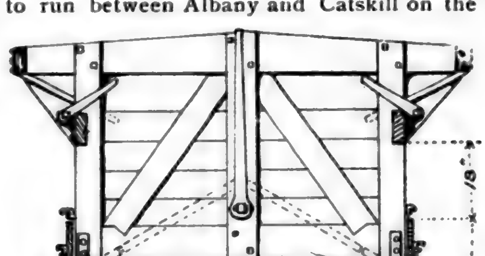


Fig. 9.

Fig. 6 shows the valve-replacing gear; the lever *R L* is operated by a man on the end platform of car. Fig. 7 shows the valve-detent arrangement; the detent withdrawing-rod, m^1, is operated by a lever at the end of the car. Fig. 8 is a side elevation of the half-length of the car, showing the adjustable side-board in place for ditching service, etc. Both valves of car are shown down. Fig 9 is an end elevation of the car, with adjustable side-boards in place, the load to be dumped half on each side. In case dumping all on one side is desired, all that is needed is to raise one valve before loading.

The construction of the car in its improved form will readily be understood from the engravings.

Cars.

THE Indianapolis Car & Manufacturing Company recently delivered 100 fruit cars to the Louisville & Nashville Railroad.

THE Michigan Car Company, Detroit, Mich., is building 600 box cars for the Toledo, St. Louis & Kansas City Railroad.

THE Ohio Falls Car Company, Jeffersonville, Ind., has its passenger-car shop busy on orders. The freight shop is building 200 box cars for a Southern road.

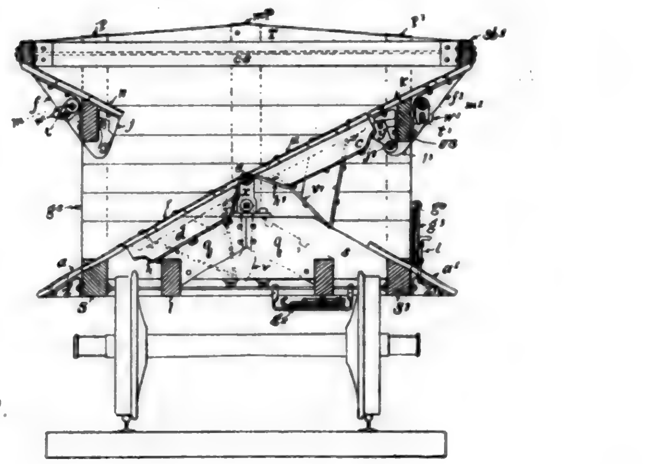


Fig. 2.

THE Pullman shops at Pullman, Ill., have completed 45 passenger cars for the Philadelphia & Atlantic City Railroad.

Marine Engineering.

THE Continental Iron Works, Brooklyn, N. Y., recently launched an iron propeller, called the *General Butterfield*, and intended to run between Albany and Catskill on the Hudson River. The *Butterfield* is 130 ft. long on the water-line and 140 ft. over all; 28 ft. beam and 9 ft. 6 in. depth of hold. The motive power will consist of compound engines 17 in. high-pressure and 32 in. low-pressure cylinders and 24 in. stroke. The boilers will be of the ordinary horizontal tubular type. She will have three water-tight bulkheads and steam-steering apparatus.

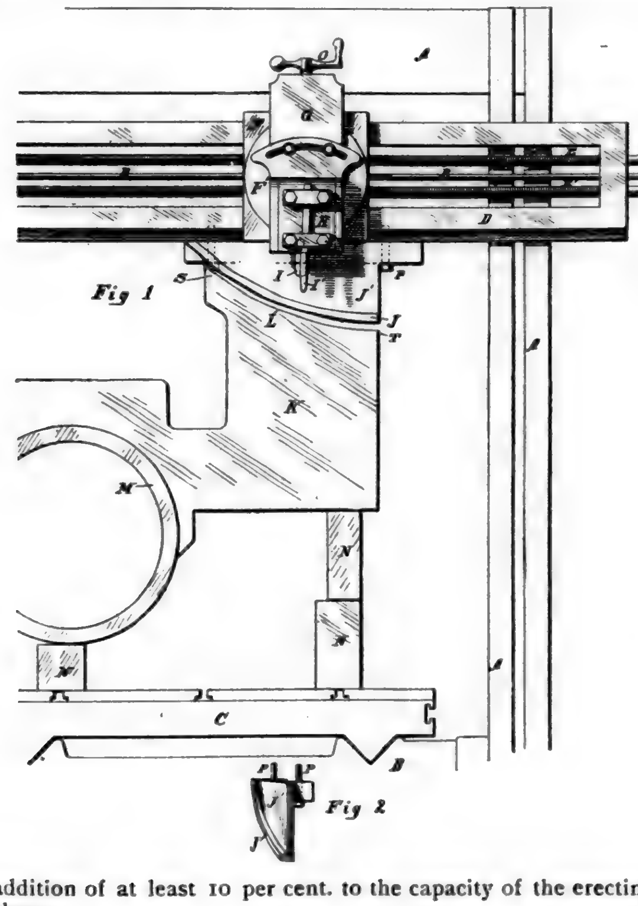
THE Risdon Iron Works, San Francisco, have recently fitted the steamer *Australia*, running between that port and Honolulu, with new boilers and triple-expansion engines. The boilers are of steel, and will carry 160 lbs. working pressure; they are two in number, 14 ft. 4 in. mean diameter, 16 ft. 4½ in. long; each boiler is fitted with 6 Fox corrugated furnaces, 3 ft. 4 in.

mean diameter, $\frac{1}{3}\frac{7}{2}$ in. thick, having one fire-box common to each pair of through furnaces.

Planer Attachment for Curved Surfaces.

THE accompanying illustration shows an attachment for an ordinary planing machine, intended for use in planing curved surfaces, and especially the saddles of locomotive cylinders. This work, as is well known, is now done in a very crude way, by chipping the ribs, with which the saddle is made, by hand. The mechanic has to chip a large area of iron, just as it may happen to come from the sand, to fit the curvature of the boiler. In doing this it is necessary to lift the boiler into and out of the saddle until a trial fit is secured.

It may be mentioned that in one of the largest railroad shops in the country the price paid for chipping a saddle is $8.40, and the job usually takes four men a day. This means a day of track-room, often a valuable consideration when work is in a hurry. If this day could be saved it would be equivalent to an



addition of at least 10 per cent. to the capacity of the erecting shop.

This saving of time is not the only reason for doing this work by machinery. It is a common custom to use a sledge-hammer to pound the smoke-box so as to make a quick fit, and this is, of course, likely to strain the boiler in an undesirable way.

The attachment, which may be applied to an ordinary planer, is shown in the accompanying cut. Fig. 1 is a partial front view or elevation of a double-headed planing-machine, with the device attached thereto, only one head of the machine being shown ; fig. 2, a small detached perspective view of the templet for the tool-holder.

The operation is as follows : The cut begins at the point *S*, and terminates at *T*. Thus, looking at the drawings, the traverse of the plate *F* on the screw-threaded rod *E'* is from left to right. The plate *G* is kept depressed by the operative, so as to hold the lower edge of the round-ended pin *I* down upon the templet *J*. After the carrying-plate *C* has carried the saddle under the tool *I'* for the whole length of the saddle, the plate *C* is returned to the starting-point, and the tool is automatically shifted to the right for the next line of cut, in the usual way. This operation is repeated, the operative keeping the pin *I* down to its place on the templet *J*, until the whole width of the curved surface is planed. If it is found that one traverse of the whole curved surface is not sufficient, the operation can be repeated until sufficient metal has been removed to suit all requirements.

All boilers are accurate enough in diameter and general lines to conform with the surface of the saddle when planed.

This device is covered by patent No. 390,294, issued recently to G. M. Griffiths, of Philadelphia.

Blast Furnaces of the United States.

THE *Iron Age* gives the following statement of the blast furnaces on June 1, showing their condition and weekly capacity in tons :

Fuel.	In Blast. No.	In Blast. Weekly capacity.	Out of Blast. No.	Out of Blast. Weekly capacity.
Charcoal	60	10 962	96	8,754
Anthracite	91	34,386	82	24,728
Bituminous and coke	135	91,771	81	40,374
Total	286	137,119	259	73,856

The decrease in furnaces in blast during May was 10 in number, with a weekly capacity of 7,224 tons.

Comparing the statement with that for June 1 of last year, we find the number of furnaces in blast and their weekly capacity as follows :

	1889.	1888.
Furnaces in blast	286	298
Weekly capacity, tons	137,119	123,015

The *Iron Age* says : " The production of pig iron shrinks from month to month, but the falling off is not so great as would be supposed. Our reports show that the output is still very heavy, when the condition of the trade is taken into consideration. At the same time a distinctly hopeful feeling characterizes the communications we have received from the furnace men. Many of them report diminishing stocks and increasing inquiries."

Electric Notes.

THE Thomson-Houston Electric Company, Boston, is erecting one of its electric welding machines at the National Tube Works at McKeesport, Pa. This machine is to weld extra heavy pipe, from 1 in. to 3 in. diameter.

THE Westinghouse Electric Company, Pittsburgh, intends to have its new electric car on the market by the opening of the fall. It is said that a number of railroad companies are awaiting the completion of the car to test its practicability. The overhead system will be used. The new car will employ a Tesler motor, without any brushes or commutator, besides which no gearing will be employed. The alternating current will be used, which will reduce the size of the wire and largely augment the efficiency of the apparatus.

Locomotives.

AMONG other orders, the Baldwin Locomotive Works, Philadelphia, are filling one for 25 engines, with 19 × 24 in. cylinders, for the Texas & Pacific, and one for 15 freight engines for the Missouri, Kansas & Texas Railroad.

THE New York Locomotive Works, Rome, N. Y., are building four passenger engines for the Mobile & Ohio Railroad.

THE Cooke Locomotive Works, Paterson, N. J., recently delivered six passenger engines, with 19 × 24 in. cylinders, to the Newport News & Mississippi Valley Company.

THE Old Colony Railroad shops at South Boston have just completed four heavy passenger engines for the road.

Bridges.

THE Berlin Bridge Company, East Berlin, Conn., recently completed a bridge of 300 ft. span over the Connecticut River at Brattleboro, Vt.

THE Shiffler Bridge Works, Pittsburgh, Pa., have the contract for an iron bridge over the Kentucky River at Tate's Ferry, Ky. The channel span will be 300 ft. long.

THE King Iron Bridge & Manufacturing Company, Cleveland, O., is building 11 spans of iron bridge for the Richmond & Danville Railroad.

THE Variety Iron Company, Cleveland, O., is furnishing the iron work for a new bridge at Athol, Mass.

OBITUARY.

Silas H. Witherbee, who died in New York, June 8, aged 74 years, was born in Bridport, Vt., and when but a boy entered a store in Port Henry, N. Y., as clerk. Subsequently he was connected with the Port Henry Furnace and later ran a transportation line on Lake Champlain. He went into the iron-mining business in 1852, and soon after formed the firm of Witherbees, Sherman & Company, which gradually became miners of iron ore on a very large scale, and owners of the Lake Champlain & Moriah Railroad, built to accommodate their business. He was also chief owner of the Port Henry and the Cedar Point furnaces, and held a very high position in the iron trade. Mr. Witherbee left a large fortune, chiefly invested in mining property and in real estate on Lake Champlain, in New York City, and in Newport.

PERSONALS.

Peter Brady is Chief Engineer of the new Easton & Northern Railroad, and has his office at Easton, Pa.

Major R. A. Bacon has resigned his position as Superintendent and Chief Engineer of the Rome & Decatur Railroad.

S. D. Burton has resigned his position as Superintendent of the Second Division of the Mexican Central Railroad, and has returned to the United States, where he will remain for the present.

William Hainsworth, for a number of years Superintendent of the Pittsburgh Steel Castings Company, and more recently President of the Hainsworth Steel Company, has resigned both positions.

J. A. Wishart, late Master Mechanic of the New York & Canada Division of the Delaware & Hudson Canal Company's lines, has been appointed Master Mechanic of the Company's shops at Oneonta, N. Y.

Charles Blackwell, recently with the Central Railroad of Georgia, and formerly with the Union Pacific, has connected himself with the United States Metallic Company, of Philadelphia, and will have his headquarters in Chicago. Mr. Blackwell is a mechanical engineer of high reputation and extensive experience.

PROCEEDINGS OF SOCIETIES.

American Institute of Electrical Engineers.—The fifth annual meeting was held in New York, May 21. The following officers were elected, who, in addition to those holding over under the rules, will form the board of management until the completion of the fiscal year of 1890: President, Professor Elihu Thomson, Lynn, Mass. Vice-Presidents, Edward Weston, Newark, N. J.; Professor E. L. Nichols, Ithaca, N. Y.; Major O. E. Michaelis, Augusta, Me.; Dr. Louis Duncan, Baltimore. Managers, Dr. F. Benedict Herzog, H. C. Townsend, Henry Van Hoevenbergh, New York; Professor William E. Geyer, Hoboken. Secretary, Ralph W. Pope. Treasurer, George M. Phelps, New York.

The Council reported that there had been a net gain in membership of 60 during the past year.

The regular meeting for the presentation and discussion of professional papers was held on May 22.

The closing session of the general meeting took place at the College of the City of New York, in the evening of May 22, when Professor H. A. Rowland delivered a lecture on Modern Views in Respect to the Nature of Electric Currents. The lecture, which was illustrated by numerous experiments, was listened to with the greatest interest by over 300 persons, among whom were many of the representative electricians of the country.

Northwest Railroad Club.—At the regular meeting in St. Paul, Minn., June 8, there were discussions on Axle Dimensions and on the Rules of Interchange. Arrangements for attendance of members on the Master Mechanics' and the Master Car-Builders' conventions were also made.

New England Water-Works Association.—The eighth annual convention was held at Fall River, Mass., beginning June 12. Business sessions were held on that and the following day, at which a number of papers were read on Hydrants; Meter Rates; Records; Analysis of Water, and other subjects. There were also discussions on Sediment in Mains; Size of Pipes; Repairing Pipes; Lead Pipes; Lift for Pumps; Water Motors; Consumption and Waste; Driven Wells, etc.

June 14 was devoted to a programme of entertainment provided by the local committee.

American Society of Civil Engineers.—At the regular meeting, June 5, the death of General Adna Anderson was announced.

A paper on the Flood-heads of the Mississippi River, by William Starling, was announced, but its reading was postponed to the annual meeting at Seabright.

The most of the meeting was occupied by a discussion of the Johnstown disaster. Several members described the dam and the circumstances of its construction. By vote of the meeting Messrs. W. J. Becker, J. B. Francis, W. E. Worthen, and Alphonse Fteley were appointed a committee to visit the site of the South Fork Dam and report on its failure.

The tellers announced the following elections:

Members: Martin Gay, New York; Julien Astin Hall, Washington; Frank Nearing, Tarrytown, N. Y.; George Spencer Pierson, Kalamazoo, Mich.; Arthur Burr Starr, Allegheny, Pa.

Associates: Jules Breuchaud, New York; Kiosaburo Futami, Kansas City, Mo.; John Vose Hazen, Hanover, N. H.; Millard Hunsiker, Pittsburgh, Pa.; Frank Clifford Lewis, Mount Vernon, O.

Juniors: William Channing Cushing, Zanesville, O.; Thomas Francis Lawlor, Poughkeepsie, N. Y.; Merritt Haviland Smith, Jr., New York.

Engineers' Club of Philadelphia.—At the regular meeting of May 18, the Secretary presented for Mr. C. O. Vandeventer two specimens of well-preserved timber: one (part of a cart-spoke) dug March, 1889, from a bank on the old "Tape Worm" Railroad, built in 1837; the other, a section of timber measuring about 8 in. × 9 in., cut September, 1888, from a timber used in the foundation of arch culvert on the same road. The timber has been exposed to the air since shortly after the culvert was built.

Mr. F. J. Amweg presented an illustrated description of the Market Street Cantilever Bridge over the Schuylkill River, Philadelphia. This bridge was completed May 1, 1888, R. A. Malone & Sons being the contractors. The reason for the adoption of the design and full particulars and strain sheets were given in the paper. This paper was discussed by several of the members present.

At the regular meeting of June 1 Mr. R. Meade Bache read an illustrated paper by Mr. Neville B. Craig on the Vernier Telemeter.

Mr. W. A. Morse, visitor, presented an illustrated description of the Smith Feed-water Heater and Purifier.

There was some discussion by Mr. S. S. Evans.

Engineers' Club of Cincinnati.—The regular meeting was held May 23, with 25 members present. Edward Mead, of Louisville, and Henry Pierce and C. H. Schumann, of Cincinnati, were admitted to membership.

Mr. R. L. Engle read an interesting paper on the construction of the Atchison, Topeka & Santa Fé Railroad from La Junta, Col., to Deming, N. M., in 1878–81. He described also the building of the Raton Tunnel, 2,011 ft. in length, and the temporary track on switch-back location over which to pass trains during the construction of the tunnel, which is remarkable for the short time occupied in its building, and the cheapness with which it was accomplished.

Engineers' Club of Kansas City.—At the adjourned meeting, May 20, a paper on the Inspection of Iron Bridges was read by Henry Goldmark. He referred to the action already taken on highway bridge reform, but considered the safety of railroad bridges to be of still more importance, and recommended a systematic inspection of such bridges.

The paper of the evening, Sewerage of the O. K. Creek District, was read by W. Kiersted, supplemented by remarks by A. J. Mason.

Engineers' Club of St. Louis.—At the regular meeting held May 29, the Secretary read a communication from the St. Louis Public Library on the subject of membership and permanent meeting places. The question was discussed by Messrs. Johnson, Holman, Seddon, Gale, Moore, Bryan and Bouton.

A paper on a new system of Fire-Proof Flooring was read by

Mr. P. M. Bruner, giving detailed particulars regarding the manufacture, erection, durability and cost.

The paper on Settling Water, by Mr. Seddon, was discussed by members present.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting was held May 22, President Brashear in the chair. After the election of four members, Louis S. Clarke gave a very interesting account of the inception of the idea of fixing sound and the progressive steps to the present graphophone. His remarks were listened to with much interest.

Master Mechanics' Association.—The annual convention began at Niagara Falls, June 18, with a large attendance. After prayer and roll-call, President Setchel delivered the annual address, touching on the past development of the locomotive and the needs of the future. The reports of the Secretary and Treasurer were read and received, and the usual Committees on Nomination, Auditing, and Correspondence appointed. A number of new members signed the roll.

The Committee on Purification of Feed Water presented no report and was discharged, the subject being continued with a new committee. Reports were read from the Committee on Tires, the Committee on Form and Size of Exhaust Nozzles, and the Committee on Driving and Engine Truck Brass, the latter recommending as a new departure, the casting of boxes of solid bronze or brass. All the reports were discussed.

The volunteer discussions for the day were on the Bursting Steam Chests and on the Need of a Heavier Axle for Tenders.

On the second day reports were read and discussed from the Committees on Driver Brakes, on Boiler Covering, on Proportion of Grate Area and Flue Surface, on Form of Foundation Ring for Boiler Leg, and on Water Space around Fire-box.

The discussion on a new Tender Axle was continued, and joint action with the Master Car-Builders' Association on a heavier axle was advised.

The discussions of the second day on the reports on Driving Axle-boxes and on Driver-brakes were active, and called out many different opinions. The volunteer questions for the day were on Heavier Tender Axle and a new Standard Journal; on relative size of Cylinders and Smoke-stacks, and on Iron and Wooden Tender Frames. Time only permitted the discussion of the first.

On the third day the reports on Water Space in Boilers, on Foundation Ring for Boiler Legs, and on the Mechanical Influence of Iron and Steel on Watches of Locomotive-Runners were read and discussed.

The Committee on Subjects reported the following:

1. Compound Locomotives.
2. Testing Laboratories, Chemical and Mechanical.
3. Link Motion as Compared with Other Valve Motions.
4. Aside from Increased Grate Area, are there any other advantages to be gained by placing Fire-boxes above the Frames?
5. Steel *vs.* Iron Frames.
6. Brick Arches in Locomotive Fire-boxes.
7. Locomotive Tanks or Tenders; best method of preventing Corrosion in Coal-space.
8. The best proportion of Steam Passages in relation to size of Cylinders and Steam Pressure.

Upon motion these were also included:

9. Best Form and Size of Axles for Heavy Tenders.
10. What is the relative value of Small and Large Flues?

Resolutions were adopted for the appointment of a committee in relation to the standard coupler.

Chattanooga, Buffalo, and Montreal were designated as the places from which the Executive Board is to select the place for the next Convention. The usual resolutions of thanks, etc., were passed.

The following are the officers for the ensuing year:

President, R. H. Briggs, Memphis, Tenn.; First Vice-President, John Mackenzie, Cleveland, O.; Second Vice-President, Albert Griggs, Providence, R. I.; Secretary, Angus Sinclair, New York; Treasurer, O. Stewart, Charlestown, Mass.

The exhibition room provided this year was unusually large, and there were many exhibits of old and new devices, of which space will permit only a mention by name, as follows:

Car Heaters and Steam-pipe Couplings.—Erie Car Heating Company; Standard Car Heating Company, Pittsburgh; Williames Car Heating Company; Leland's Universal Coupling, New York; Northwestern Modern Car Heating & Lighting Company; J. M. Foster's Pressure Regulator; Mason Pressure Regulator; Gold Steam Trap; Ross Valve Company, Troy, N. Y., Reducing Valve.

Car Wheels.—New York Car Wheel Company, machined wheel; Boies Steel Wheel; Griffin Wheel & Foundry Company.

Couplers, Buffers and Drawbars.—Westinghouse Buffer; Butler Drawbar Attachment; Robinson Coupler Company, Springfield, O.; Tocin Automatic Car Coupler Company.

Snow-plows.—Jull Manufacturing Company, model of "Cyclone" plow; Rotary snow-plow, photographs.

Brakes.—Eames Vacuum Driver Brake; John Porter, Jackson, Mich., coupler for air-brakes.

Car Seats.—Scarritt Furniture Company, chairs and Forney car seat; Hale & Kilburn; Hartford Woven-Wire Mattress Company.

Car Springs.—A. French Spring Company, Pittsburgh.

Train Signals.—Griggs Automatic Air Signal Company.

Tools, etc.—Star Machine Company, Buffalo, Forge; Halsey Power Drill, J. J. McCabe, New York; C. F. Hall, Skaneateles, N. Y., Valve Refitting Machine; Belfield Injector, Philadelphia; Buffalo Steam Pump Company.

Boiler Covering.—Chalmers-Spence Company, Asbestos Felt; Shields & Brown, New York, Boiler Covering.

Jacks, etc.—D. E. McSherry & Company, Dayton, O., Maxon Jack; Chapman Jack Company, Cleveland, O.; B. E. Tilden & Company, Cleveland, O., Replacing Frogs.

Metals.—Anti-Friction Metal Company, North East, Pa., Tempered Copper; Damascus Bronze Company, Pittsburgh; Thomas Prosser & Son, New York, Krupp Steel; Fox Solid Pressed Steel Company, Chicago; Buffalo Steel Foundry; Schoen Manufacturing Company, Philadelphia, Pressed Steel; Thomson-Houston Electric Welding Company, Boston.

Valves.—Richardson Balanced Slide Valve, Troy, N. Y.; Woolf Valve Gear Company, Minneapolis, Minn.

Packing, etc.—United States Metallic Packing Company, Philadelphia; Otley's Eureka Steam Packing, Chicago; Fairbanks & Company, Asbestos Valve-disks; American Indurated Fiber Company, Mechanicville, N. Y., Fiber Pipe, etc.

Miscellaneous.—E. Smith & Company, New York, Paints and Varnishes; Detroit Lubricator Company, Sight-feed Lubricators; Kalamazoo Railroad Velocipede Company; Smith's Portable Rail-saw; Hartford Steel Railroad Tie; Robinson's Security Railroad Check, New York; Union Manufacturing Company, New Britain, Conn., Skinner Combination Chuck.

On the second day a number of belated exhibits arrived, including the following:

Beaudry Forging Press; McGuire Manufacturing Company, Chicago, Star Grain Door; Fish Car Truck, Detroit; Lake Shore Locomotive Condition Indicator; Ashcroft Manufacturing Company, Boston, Valves, Indicators, etc.; Consolidated Safety Valve Company, New York; Fennell Car Coupler, Skaneateles, N. Y.; Barnum Cylinder Relief Valve, Buffalo, N. Y.; Hoffman Machine Company, Detroit, Mich., Pendry Balanced Throttle Valve; Guarantee Tool Company, New York, Samson Wrench; Gould-Tisdale Revolving Semaphore, Boston; Shaffer's Oil Saver; Jerome Metallic Packing; Western Valve Company, Chicago; Knapp Steam Coupler; Susemihl's Car-door, Grain-door, Side-bearing for Car Trucks and Axle-box Cover; Metallic Grain-Door Company, Detroit.

NOTES AND NEWS.

The International Marine Conference.—The delegates from the United States to the coming International Marine Conference met in Washington, April 25, and organized. At various meetings since held they have completed a detailed programme of subjects to be considered which will be transmitted to the several powers who have agreed to take part in the Conference in October next. The general headings of this programme are as follows:

1. Marine signals or other means to plainly indicate the direction in which vessels are moving in fog, mist, thick weather or snow, and at night. Rules for the prevention of collisions. Rules of the road at sea.
2. Regulations to determine the seaworthiness of vessels.
3. Draft to which vessels should be restricted when loaded.
4. Uniform regulations regarding, designating and marking of vessels.
5. Saving life and property from shipwreck, including saving from shipwreck by operations from shore; official inquiries into shipwrecks.
6. Necessary qualifications for officers and seamen, including tests for sight and color blindness.
7. Lines for steamers on frequented routes.
8. Night signals for communicating information at sea.
9. Warnings of approaching storms, including transmission of warnings and uniformity of signals.
10. Reporting, marking, and removing dangerous wrecks and obstructions to navigation.
11. Notice of dangers to navigation. Notice of changes in lights, buoys, and other day and night marks.

12. A uniform system of buoys and beacons.
13. Establishment of a permanent international maritime commission.

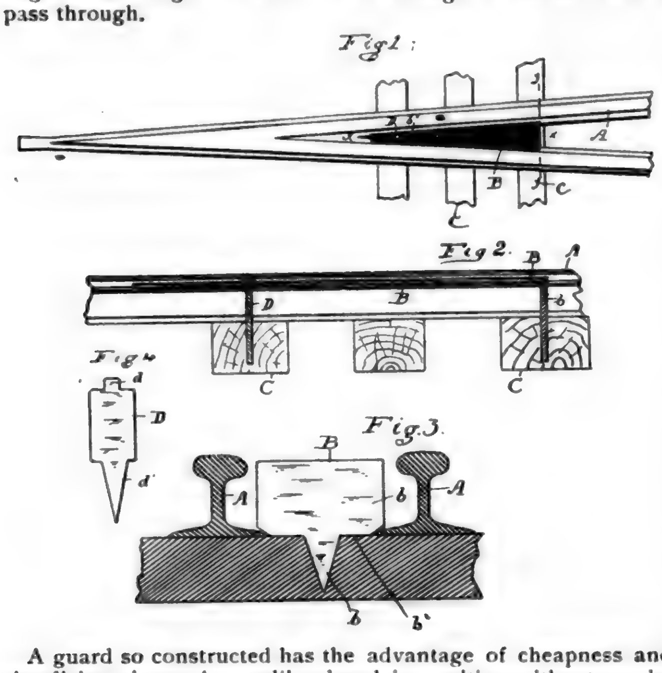
Foot-guard for Frogs and Switches.—The accompanying illustration shows a new pattern of foot-guard for frogs and switches. Fig. 1 is a plan view of the foot guard in place at a frog. Fig. 2 is an enlarged section through the line $x\ x$ of fig. 1; fig. 3 is an enlarged view on the line $y\ y$ of fig. 1; fig. 4 is a detail of spike.

A represents a frog of ordinary construction, but it is evident that the guard can be used in any tapering space between rails.

B is the guard, which consists of a tapering piece of metal, preferably iron, the larger end, *b*, turned down at right angles, or nearly so, and pointed in such a manner as to be driven into the tie. A shoulder, b^2, is formed to limit the depth to which the end can be driven into the wood of the tie. A number of holes, b', are formed in the guard near the smaller end, this line of holes extending over a space greater than the distance between the ties, so that one of them will always come over a tie.

A spike, *D*, is provided for the purpose of supporting the smaller end of the guard. This spike has at its upper end a tongue *d*, adapted to fit the holes b' of the guard and to extend through the same sufficiently far to be riveted on the upper side. On the lower end of the spike a shoulder limits the extent to which it may enter the tie. The guard is placed in position by driving the large end into a tie at a suitable point, passing the head of the spike *D* through one of the holes b', which comes over a tie, driving the spike into the tie, and riveting the head of the spike in place. The length, width, and the taper of the guard are to be adapted to the position in which it is used, although it is not necessary to have each guard fit exactly, as one size will fit a variety of angles. It is only necessary that the guard shall fill the space so that no opening is left large enough to allow the foot to enter.

The height of the upper surface of the guard is governed by the position of the shoulder b^2 and the shoulder on the spike *D*. As here shown, the upper surface of the guard is approximately on a level with the top of the rail; but when placed where the flanges of the wheels pass over it it may be made lower, so that it just clears the edge of the flange, or it may be made level with the top of the rail, as shown, with a space between its edge and the edge of the rail for the flange of the car-wheel to pass through.



A guard so constructed has the advantage of cheapness and simplicity; it can be readily placed in position without special adjustment, and it will remain in place without liability of being displaced. A few different sizes of guards will fit the many places on a railroad where they are needed.

This foot-guard is the subject of Letters Patent No. 402,209, recently issued to Charles H. Wakefield, of Sherbrooke, Canada.

Russian Method of Timbering Wells.—A plan for timbering wells in order to protect the diggers from slides and falling of earth, which is shown in the accompanying illustration, is used extensively in Russia. Fig. 1 shows such an arrangement with squared timber, and fig. 2 with round timber or logs; the latter is more generally used.

The frames or shafts are generally square, from 56 in. to 84 in. on a side; they are made of logs from 6 in. to 10 in. in diameter. At the ends tenons are cut about as long as the diameter of the log and one-half its thickness. The logs, when laid together in order, thus engage at the ends and form a solid frame.

In practice the well-diggers generally excavate a hole from 4½ ft. to 7 ft. deep, according to the greater or less looseness of the soil. The box or wall is then built up, starting from the bottom of the hole, and the diggers proceed with their work, adding more logs from below, so that the framework is continually growing downward, so to speak.

When the excavation reaches a point within about 7 ft. of the subterranean stream or spring, as ascertained by sounding or boring, the frame is no longer carried straight down, but is gradually spread by making each course of logs a little larger

Fig. 1

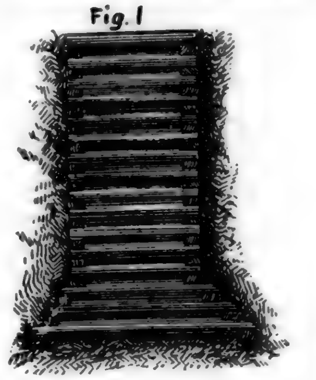
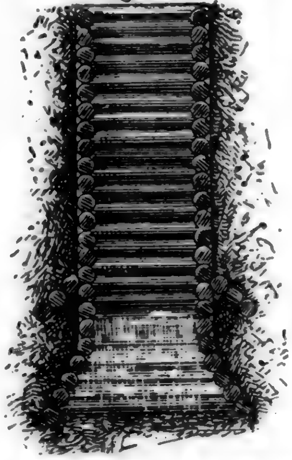


Fig. 2.



than the one above it; the base or bottom thus forms a square truncated pyramid, the faces being inclined about 40°. After striking water the lower part of the frame is carefully braced to keep it in place, and the well proper, or part which collects the water, and from which it is taken by the pump, is built below. The top of this is generally the same size as the lowest course of logs of the frame; its size and depth vary according to circumstances.

Arrangements for lining and curbing also vary, but the curb can readily be fastened to the top of the frame. It should be noted that the earth is carefully packed down around the frame when it is first put in place.

Scientific Judges.—Our readers may remember that, last autumn, *apropos* of a great patent case of colossal dimensions which was then before the Courts, we published an article urging that, in the interests of speedy justice, no less than for the dignity of science and its professors, it was most desirable that advantage should be taken of the provisions which already exist in our law, and especially in the Judicature Act of 1873 and its amending statutes, and in the rules of the Supreme Court framed under them, for the employment of scientific assessors or experts to aid the judge in strictly scientific cases. It may be remembered that, even in the very case on which we then commented, the tardy employment of Professor Stokes to aid Mr. Justice Kay was productive of most satisfactory results. We are glad, therefore, to notice that, in a case of some difficulty which came before Lord Coleridge last week, the same eminent man was again called in, and again with the result of relieving the Court from the task of hearing a mass of expert evidence with which no judge and jury are competent to deal satisfactorily. The whole question at issue was whether a certain anemometer, of which one of the parties was patentee and the other the purchaser, came up to the description of its qualities given by the vendor. A considerable array of counsel appeared on both sides, and it was arranged that the services of Professor Stokes should be called in to the aid of the Court. Seven of the anemometers were submitted to him, and, after an investigation by him, his report was read, and upon it judgment was given. The result is, that the report of the case occupies less than a third of a column of the *Times*. Without the services of Professor Stokes, or some similar sworn expert, we should have had half a dozen or more expert witnesses on one side contradicted by half-a-dozen expert witnesses on the other side; a case which would have lasted three or four days before a wearied judge, conscientiously striving to understand purely technical details, and a perplexed and confused jury; great loss to both parties; an unsatisfactory result; and, as we think, no little scandal to science and scientific men. All this has been prevented by the very simple expedient of calling in an eminent man of science to make a sworn report on the purely technical details, and leaving the rest to the ordinary administration of our Courts. Herein, we are persuaded, lie the proper functions of scientific men in the administration of public justice.—*Nature.*

THE RAILROAD AND ENGINEERING JOURNAL.

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NEW YORK, AUGUST, 1889.

THERE seems to be much activity in railroad building in the far East. In India a great deal of work is going on, chiefly in the building of lines to develop the wheat-growing districts—a matter which has considerable interest for us in this country—and in Burmah the English are pushing the construction of lines in their newly-acquired territory. In Siam some surveys are in progress for a system of lines, although it is uncertain yet how much work will be done, if any, while in Sumatra two lines of considerable local importance are under construction by the Dutch. No work from these quarters, however, is likely to come to this country, the material being all supplied from Europe.

IN Japan, as was noted in our columns some time ago, a good deal of work is going on on new railroad lines both for the Government and for private companies. Early in April the trunk line connecting Tokio, Kioto, and Osaka was finally completed and opened for business. The Sendai Line, which is to stretch the whole length of the main island from Tokio to its northern extremity, is opened for about half of its length, and on the remainder considerable progress has been made. Work is also in progress on several branch lines, and at the present rate it will not take very long for the railroad system of Japan to assume importance both on account of its mileage and the amount of its business.

THE Russian Trans-Caspian Line, although built, as we have heretofore said, entirely for military purposes, is already carrying a commercial traffic which more than pays its working expenses, and a beginning will soon be made on the extension of the main line to Tashkend. The latter city is an important center, both commercially and politically, and is also situated at the head of navigation of the Syr-Daria River. Besides this extension a considerable amount of work is to be done on the Trans-Caspian road, so as to increase its carrying capacity and to give it a more permanent character than was at first done.

In this connection we may note that the management of the railroad has undertaken to provide for the little Russian colonies along the line of the road, which are mainly composed of employés of the road and their families, by fitting up a car as a school-house and another one as a church. These cars contain sleeping accommodations and other provisions for the comfort of their occupants, and are moved from station to station, so that the schoolmaster and the priest are enabled to attend to the mental and spiritual wants of a very widely scattered population with comfort to themselves, and with very little loss of time.

THE engineers who have been making the preliminary surveys for the Siberian Pacific Railroad have been for some time past occupied in preparing their reports, and the result of their work, it is stated, is considered very satisfactory by the Russian Government. The surveys have shown that the greater part of the work will be comparatively light, and that heavy grading will be needed only at a very few points. The largest and most expensive engineering work will be the bridge over the river Irtish, which will be 1,900 ft. long. There are several other important river crossings, but none of them more than 800 to 1,000 ft. in length. The estimate for the cost of the entire line, with pile or other wooden bridges, and with a moderate amount of rolling stock, is 25,000 rubles per verst, or $19,000 per mile.

The route selected runs from Zlatoust by way of Kourgan, Omsk, Tomsk, Irkutsk, thence across the Southern Baikals, through Posolskaya, Tchita, Sraitensk, and the Amoor Valley to Vladivostock.

Practically work has already been begun, as a commencement has been made on the extreme eastern end of the line, which is to connect Vladivostock with the Amoor settlements, while on the western end progress is being made on the line from Ufa to Zlatoust, which is really the first section of the road.

The undertaking is a very popular one in Russia, and is also said to be a favorite project of the Czar, so that there is every probability that work upon it will be undertaken in earnest within a short time, especially as Russia is just now in a very good financial condition.

THE relative advantage of the broad and narrow gauge is a question which has passed beyond the point of argument in this country, having been practically settled by the gradual disappearance of the narrow gauge, but it is still under discussion in India, and some curious remarks on this subject are made in a paper recently read by Mr. Waring before the Institution of Civil Engineers. The result there has been generally the reverse of what was expected by the advocates of the narrow gauge, for the cost of working those lines has been generally much higher, in proportion to the receipts, than that of the broad-gauge lines. This has partly been due to the fact that they are generally roads of much lighter traffic, but the fact remains, as stated by Mr. Waring, that taking the average of all the lines of meter gauge—which was the gauge adopted for the narrow lines in India—the cost per ton-mile for all working expenses and per locomotive-mile for motive power were considerably higher than on the roads of 5 ft. 6 in.—the Indian standard—and the only single item upon which the narrow gauge showed an advantage in working was in repairs of cars. As to the difference in

first cost, Mr. Waring thinks that the only gain was due to the fact that most of the narrow-gauge lines were built for a light traffic and in a much less substantial manner than the others; this seems to be confirmed by the statement that the expenses of maintenance of way have been much higher in proportion on those lines.

THE Verrugas Viaduct, which was built in 1872, and which at that time attracted much attention from the daring nature of its design, and from the fact that it was then the highest bridge in the world, or one of the highest, was destroyed in March last by a landslide, which swept down the ravine spanned by the bridge, carrying away the central pier and the two spans which rested upon it. This bridge carried the Lima & Oroya Railroad over a deep ravine, through the bottom of which flowed the little River Rimac, and was built by the Baltimore Bridge Company. It consisted of four spans supported by two abutments and three iron towers, which were respectively 179 ft., 252 ft., and 146 ft. high from their masonry foundations.

The Lima & Oroya Railroad, which was intended to cross the Andes and establish connection between the coast and the famous Cerro de Pasco silver mines, and also to connect Peru and Bolivia, was one of the works undertaken by Henry Meigs for the Peruvian Government, and was one of the most notable railroads in the world, involving much extremely difficult and expensive work, including tunnels, bridges and embankments. A large amount of money was spent upon it, but owing to the condition of the Peruvian Government it has remained unfinished, and has been of comparatively little importance commercially.

ONE of the events which will take place in Paris this summer is an International Geographical Congress, which will sit in that city, August 5-11, and to which delegates from organized societies all over the world are invited. The Congress will be divided into six sections, and committees are preparing, as far as possible, the business for each. The divisions are as follows:

1. Mathematical: Geodesy, Hydrography, Topography, and Cartography.
2. Physical: Meteorology and Climatology, Geology, Botanical and Zoological Geography, Oceanic Geography, Ethnology, Medical Geography.
3. Economical: Commercial and Statistical Geography.
4. Historical: History of Geography and Cartography.
5. Didactic: Diffusion of Geographical Knowledge.
6. Travels and Explorations.

Geographical societies all over the world are asked not only to send delegates, if possible, but also to contribute accounts of geographical progress in their respective countries, including notes of travel and exploration, etc. These notes are to be compared and edited by a committee which will be appointed at the Congress, and are finally to be published in book form as the record of geographical progress in the nineteenth century. The attendance at the Congress will, it is expected, be large, and many distinguished men will be present.

THE statistics of geographical societies throughout the world have been collected by Herr H. Wichmann, the result of whose investigation is given by the *Bulletin* of the American Geographical Society. According to this authority the societies devoted to geographical science number in all 101, with 44 branches, and these are located in 21 countries and 135 cities. The French are usually credited with not caring much for what goes on outside of their own country, but nevertheless France takes the lead with 29 societies, having 19,800 members. Germany, which might be expected to be first, follows at a long interval, having 22 societies, with 9,200 members. Great Britain has nine societies, with 5,600 members; Austria-Hungary two, with 1,950 members; the United States three, with 1,500 members; Russia five, with 1,330 members; Switzerland six, with 1,000 members; no other country having more than one society. Russia and the United States, as the two nations having the most extensive territory and the greatest opportunities for development, might be expected to make a better showing, although it may be said that they are both too much occupied in making geography to have much time for studying it.

The geographical journals of the world—including only those exclusively devoted to that subject—number 130. Of these 45 are published in the French language; 41 in German; 10 in English; nine in Russian; six in Italian; six in Portuguese; five in Spanish; three in Dutch, and one each in Danish, Swedish, Hungarian, Roumanian, and Japanese. These journals are classed by languages and not by countries; for instance, the French include two or three published in Belgium, the German those published in Austria as well as in Germany, and the English those published in the United States. No attempt has been made to otherwise classify these journals, which differ very widely in size and in the value of their contents, some having merely a transient interest, while others are of more permanent value, from the nature of their contents and the ability with which they are conducted.

THE protection of workmen from accidents and the prevention of accidents in factories are now engaging much attention in France. The present movement is a little remarkable from the fact that its chief promoters do not rely upon Government aid or Government regulation, as it is the usual French custom to do, but advocate independent action. An Association for the protection of workmen from accidents has been established in Paris and has formed branches in many of the manufacturing cities throughout Erance, and this Association has already made considerable progress in its work. It is an enlargement or copy of a similar society which has existed for some years at Mulhouse, in Alsace.

This Society acts through a corps of inspectors, composed of engineers and of experienced workmen, who visit factories with the consent of the proprietors, generally freely given, giving advice in relation to the proper safeguards to be employed with machinery and to the use of various safety devices, and in general acting as consulting engineers. Pamphlets on measures for prevention of accidents are also issued and circulated largely among mill-owners and workmen, and, in general, efforts are made to educate public opinion in this respect.

From some interesting statistics given by the Society it appears that for a series of years, what might be called factory accidents or accidents to workmen resulting directly from their work have been in the proportion of about 47 to each 1,000 persons employed; these figures being collected from establishments employing very nearly 2,000,000

workmen. From a careful analysis of these accidents and their causes, it is estimated that 20 per cent. of them are due to the carelessness of the workmen themselves; 30 per cent. to the absence of proper safeguards, while perhaps 50 per cent. might be considered unavoidable. It is believed, however, that the 50 per cent. could be considerably reduced by the use of proper precautions.

TWO extensions of the present elevated railroad system in New York might be suggested, which would certainly add very much to its efficiency. Both of them have probably been considered by the Company, and both have probably occurred to almost every one who has studied the subject at all. The first is an extension of the Third Avenue Line from its present terminus transversely, on a line nearly parallel to and not very far from the Harlem River, to a junction with the Sixth Avenue Line near its present terminus. This would make of the Third and Sixth Avenue lines a continuous belt line, would obviate the necessity of turning trains, enable trains to be run almost continuously, and would furnish needed accommodations for a section of the City which is filling up very rapidly. The other is a continuation of the present Forty-second Street Branch from the Grand Central Depot to a junction with the Sixth, and, if possible, with the Ninth Avenue Line. This would make an additional loop or cross-connection, and would be of great service to the large travel to and from the Grand Central Station.

THE resignation by Mr. Albert Fink, of the office of Trunk Line Commissioner, leaves vacant a very important position, of which Mr. Fink has been the only incumbent. It will be difficult to find a successor who unites in his own person so many qualifications for the work. As General Superintendent of the Louisville & Nashville Railroad, Mr. Fink distinguished himself, not only as a railroad manager, but as a man who had carefully studied and thoroughly mastered the intricate problems attending the course of railroad traffic in this country. As Commissioner of the Southern Railroad & Steamship Association, he showed himself capable, not only of understanding a difficult situation and of holding together the Association against very strong disturbing influences, but also of commanding the entire confidence of the members at a time when their interests were often widely opposed. When the Trunk Line Association was formed his reputation was so high that he was really the only candidate named for the office of Commissioner, and it is largely due to his exertions and to the confidence felt in him that even the limited success which it has obtained was secured.

THE American engineers who joined in the European trip have met with a most cordial reception in England from the different Engineering Societies and from various public and municipal bodies, and have been treated in a most hospitable manner in every direction. Their visit to England has been enjoyed to the utmost, and, judging from the comments of the English engineering press, the visitors have made a very favorable impression upon their hosts. A number of the party are now in Germany, where their reception promises to be a very hearty and agreeable one.

THE survey of the waters, or Hydrography, is a branch of engineering of which very little is usually known outside of those who are directly concerned, but which is, nevertheless, of no small importance. The article on another page, in which some account is given of the methods employed and the results obtained, will be found of interest.

In this connection it may be noted that while the science itself is of very early origin, its present advanced condition is largely due to the American hydrographers who have done honor to our naval service.

THE stockholders of the Chesapeake & Ohio Canal have held a meeting in Baltimore, and authorized the President and directors to make use of all available resources for the purpose of putting the canal in repair. In spite of this action, however, it is considered very doubtful whether the canal will ever be used again as a water-way. The lowest estimate is that it will cost $250,000 to put the canal in passable condition, and $350,000 to restore it to the condition in which it was before the recent flood; and it will not be possible to have it opened for navigation until next year, even were the money immediately available. The company's credit, however, is not very good, as the canal is already overburdened with debt, and it is quite possible that the money required will not be raised unless the State of Maryland, which is the chief stockholder, comes to the rescue. The canal-bed is valuable for a railroad, but the present chances are that it will be abandoned as a navigable channel.

A COMMITTEE of the United States Senate is now engaged in investigating the practicability of building reservoirs in the Rocky Mountains and the Sierra Nevada, to store up and utilize water for irrigating purposes. A number of preliminary surveys have been made in this direction, to ascertain as nearly as possible the amount of water which can be stored, and the extent of land capable of irrigation, and public attention on the Pacific has been very strongly drawn in that direction. There is no doubt that a great deal can be done in the way of utilizing lands now considered barren by irrigation, and the object of the Senate Committee is to ascertain whether the assistance of the National Government will be required to make this available.

THE Navy Department has been reorganized under the new Secretary; the purpose of the change made being to simplify the work of the different Bureaus of the Department, and to arrange their work so as to avoid, as much as possible, interference with each other. There are eight of these Bureaus, having respectively charge of Navigation; of Yards and Docks; of Equipment and Recruiting; of Ordnance; of Construction and Repairs; of Steam Engineering; of Medicine and Surgery; and of Provisions and Clothing. In addition to these the work of the Department includes the offices of the Judge Advocate General and of the Marine Corps. The organization proceeds very much on the lines which were laid down by Secretary Whitney, but which the close of his term did not leave him sufficient time to complete.

THE RAILROAD TIME SYSTEM.

THE success of the railroad time system, which is now in general use in the United States, has naturally attracted some attention abroad, and its manifest excellence and convenience has been appreciated by railroad managers

and others, who have had some opportunity of seeing its working. In England there has been some discussion upon the question, but the differences of time in that country are comparatively so small that it is not a question of moment. On the continent of Europe, however, and especially in France and Germany, it has been taken up, and the adoption of something similar to the American system finds many advocates.

The latest of these is Dr. Plechawski, of Vienna, who has been studying the question and has written an elaborate article upon it. He is not satisfied with a limited application, but, with German thoroughness, he proposes to extend it to the whole world, and to establish an international time system, by which the entire circuit of the globe shall be divided by time-meridians, at intervals of 15°, or one hour apart, so that uniform time will be kept in all places within a given time-zone. He has worked out the details of the proposed system as far as to suggest names for the 24 hours, or time-zones, into which the earth will be divided under his plan.

The advantages of our present arrangement over the confusion which formerly existed have been made so apparent by a few years of use that opposition to it has practically ceased in this country, and it is not unlikely that before long its general adoption will be secured, at least in all civilized countries. German opinion seems to be strongly in favor of it, and German influence in Europe will be of great assistance to the movement, although English opposition may for some time, by its obstinate conservatism, delay the completion of any general international agreement on the subject.

NEW RAILROAD BUILDING.

THE construction of new railroads during the first half of 1889, according to the records kept by the *Railway Age*, amounted to 1,522 miles; this mileage being divided among 123 different lines. The total amount is somewhat less than half of that reported for the same period in 1888, although the mild winter made the early part of the year unusually favorable to tracklaying in the Northern and Northwestern States. The total mileage for 1888 was about 7,100 miles, and taking the same ratio for this year, the report for the first half would indicate a total increase of railroad mileage in 1889, of about 3,500 miles. From present indications it is not at all likely to exceed that, since there are fewer new lines in progress than there were a year ago, and much less grading and preliminary work has been done.

The average length of the lines built this year, it will be seen, is between 12 and 13 miles, and this well indicates the fact, which has been stated before, that the new construction of this year is chiefly of short lines, branches, and feeders. No long lines or extensions—like the Montana Line of the St. Paul, Minneapolis & Manitoba, or the Kansas lines of the Rock Island—are now in progress, nor does it seem likely that any will be undertaken at present. The experience with competing lines in the Northwest and the Southwest has not been of a nature to encourage more building of the same kind, and, in fact, most of the companies which have been engaged in that business are not just now in a condition to keep it up. The Northwest practically stopped the building of competing lines two or three years ago, and that section of the country reports a smaller new mileage than for a number of years past.

The figures given by States are interesting. For the first time the Southern States take the lead, the five reporting the greatest mileage being Mississippi, 171; Georgia, 142; North Carolina, 106; Tennessee, 105, and Texas, 101. No other State had over 100 miles. A larger proportion has been built in the Middle States than for some years past, 87 miles having been constructed in Pennsylvania, 71 in New York, and 41 in New Jersey. In New England new railroad building seems practically to have ceased for the present; in the West and Northwest it was very light, Michigan, Indiana, Illinois, Minnesota, and Wisconsin together having only 47 miles in all to their credit; while the Southwest makes an almost equally poor showing, Missouri, Kansas, and the Indian Territory together reporting only 104 miles. On the Pacific slope also there has been a great decrease, 50 miles in California, 12 in Oregon, and 62 in Washington being the totals.

The Southern States lead this year, mainly owing to the increased activity in the development of their mineral resources and the building of short lines to open up new mining districts and to accommodate new manufacturing towns. The only long line in that section now under construction is the extension of the Georgia Pacific to the Mississippi River.

The condition of affairs shown by this statement cannot, however, be considered altogether discouraging; it is true that there has been increased difficulty in securing money for new enterprises, but the new railroads which are now being built are precisely those which are really needed by the country, and which will best aid in its development. Competing lines are at the best a doubtful investment for capital, and may be considered as, in large part, a waste of the resources of the country, which might be better applied. The growth this year is a more healthy one than that of the two or three years lately past, and the industrial interests of the country will not, in the long run, suffer seriously by the present partial suspension of activity in the direction of railroad building.

NEW PUBLICATIONS.

THE OFFICIAL RAILWAY LIST AND HANDBOOK OF USEFUL INFORMATION FOR RAILWAY MEN: EIGHTH YEAR. Chicago; published by the Railway Purchasing Agent Company.

The *Official List* is sufficiently well known to railroad men and others who have occasion to use such a publication to require no very extended notice. The present number is in the usual form, with no further changes than are needed to bring the information it contains up to date. It is a publication which is necessary to all of the very numerous class of business men and others who have occasion to communicate with railroad men of various classes and to know their addresses.

One suggestion might be made: it is their custom to publish monthly, in the *Master Mechanic*, a record of changes in railroad officers. If it is practicable to send those changes to subscribers to the *Official List* monthly in such a form—on small slips printed on one side only, for instance—that they could be cut out and pasted in their proper places in the book, it would be a great convenience to many who have occasion to use it. We give this as a hint to the publishers, who have always shown themselves

ready to do anything needed to make the list as complete as possible.

TRANSMISSION OF POWER BY FLUID PRESSURE. AIR AND WATER: BY WILLIAM DONALDSON, M.A. New York and London; E. & F. N. Spon.

This book is a statement of the rules governing the use of hydraulic pressure and of compressed air for the transmission of power, and is accompanied by a comparison of the relative advantages of the two for this purpose, to which are added a chapter and an appendix on the special case of the application of compressed air and high-pressure water for pumping sewage. It is a convenient manual for those who wish to study the subject, as the formulas given are all worked out mathematically, so that the whole process can be studied by those who desire it, and who do not want merely to accept the results, as given in the author's tables.

His opinion of the relative advantages of air and water for the transmission of power does not require much search to discover, for it is plainly expressed in the following, which is the very first paragraph in the introduction:

> It is clear that an incompressible fluid like water, subject to no changes except freezing, which can easily be guarded against, must be a much better medium for transmitting power than an elastic fluid like air, which cannot be compressed without great increments of temperature corresponding to the increments of pressure. The absolute energy imparted to the air during compression is equal to the equivalent in work of the number of thermal units required to raise the temperature of the air to that due to adiabatic compression, and must therefore be wholly lost, if the air without doing work is cooled down to the original temperature of the free air. The work done by expansion down to atmospheric pressure after cooling corresponds to an equal loss of the absolute energy possessed by the air before compression. This cooling-down to the temperature of the medium surrounding the pipes is inevitable, when the air is transmitted to considerable distances, unless the pipes are coated with some non-conducting substance. Heat must also be lost in the very act of compressing the air.

Water is very much less used for the transmission of power in this country than in England, where it is applied for many purposes and used in many places where in this country we use steam or hand-power, and lately to some extent electric motors. It has always seemed to us that the use of hydraulic machinery could be very much extended to advantage, and any book which brings the subject to the attention of engineers will be of service.

STEAM BOILERS. THEIR MANAGEMENT AND WORKING ON LAND AND SEA: BY JAMES PEATTIE. New York and London; E. & F. N. Spon.

The object of this book can probably be best expressed in the Author's own words in the preface:

> As nearly all the writers on this subject have been non-practical, therefore, notwithstanding their scientific attainments, reasonings, and data being ever so scientifically correct as a whole, their writings are void of many important details and important practical facts; and being couched in abstruse and technical language, are unintelligible to the mass of persons in charge of steam boilers, and uninteresting to others, who fail to find in them the particular counsel they desire.
>
> Under such circumstances it is obvious that much conflict of opinion and conflict of practice will exist among those in charge of steam boilers, and even among practical men, regarding the subject. Any effort, therefore, to treat the subject in a thoroughly simple yet practical manner, in the language of the engine-room, the workshop, and the factory, will be welcomed by those having a *bona fide* interest in the management and running of steam boilers.

The Author claims 30 years' practical experience, and this book is the outcome of his notes taken during that time. It relates almost entirely to English practice, but necessarily contains a great deal that will be of service to boiler-makers and boiler-users everywhere. Not all his conclusions will be accepted, but many of them are sound, and the book contains many useful hints. An excellent feature, which is lacking in too many books of this kind, is a very complete index.

The book is written in a somewhat offhand and familiar style, and a great many of the principles laid down are accompanied by illustrations drawn from practice.

REFERENCE BOOK OF INTERLOCKING AND SIGNALING DEVICES AND PARTS USED IN CONNECTION THEREWITH, AS MANUFACTURED BY THE UNION SWITCH AND SIGNAL COMPANY. Swissvale, Pa.; issued by the Company.

The title of this book does not give a distinct idea of its character. In the preface it is said that the Company has aimed to furnish a book "from which their patrons can order any part or parts entering into interlocking and signaling for repairs, alterations or additions" thereto; and also "to give as much general information as they deemed consistent with the nature of the book, and thus enable those not thoroughly versed in interlocking to intelligently select from the various devices shown one adapted to their purpose." In reviewing a really good book, adverse criticism always seems to be an ungracious act, and the duty of pointing out the defects in a work which is more worthy of commendation than condemnation is attended with more or less perplexity. If a review of such a book begins with adverse criticism, it is hard to remove the impression produced thereby by any amount of commendation thereafter. If, on the other hand, the best features are pointed out first, and attention is called to the defects last, the final, which is often the lasting impression, is an unfavorable one. In the present instance the duty devolving on the reviewer is to say, first, that this book accomplishes one of its purposes—that of a catalogue of the parts of interlocking and signaling apparatus manufactured by the Union Switch and Signal Company—exceedingly well; but the critical reader wonders why the Author, in his "endeavor to give as much general information as he deemed consistent with the nature of the book," made it as good as it is, and then did not make it much better. A comparatively small additional amount of work would have made this the best treatise on that subject in the English or, perhaps, any other language.

But to return to commendation: the book measures $5\frac{1}{2} \times 8\frac{1}{2}$ in., is bound on one of the short sides, or opens endwise, and has 364 pages printed on thin paper, so that it can be carried in an overcoat pocket. It has 136 full-page engravings and about 30 smaller illustrations, showing plans and details of signaling apparatus. The general plan of the book is to give short descriptions of the various kinds of apparatus manufactured by the Union Switch and Signal Company, and which are followed by engravings and lists of the various parts, which are designated and numbered, so that they can be conveniently ordered by those who need duplicate parts. For this purpose the illustrations are admirable, and the lists, with explanatory paragraphs, are all, apparently, that could be desired; but the descriptions of the various systems of signaling are inadequate, and not clear enough to be easily understood. For example, unless he has some considerable knowledge

of the Saxby & Farmer Interlocking Machine, it seems doubtful whether any one could understand its construction from the description on pages 8 to :6. The same thing is true of other parts. More lucid description would have added greatly to the value of the book. As it is, much of it is infuriating to a person anxious to learn how signaling apparatus of various kinds is constructed. While the reader often yearns for fuller explanation of the systems of signaling which are described, on page 66 the fact that metal expands when heated is explained at considerable length.

The book, however, has one very great merit—it is all fresh ; the engravings are from original drawings, and the mechanism illustrated is of recent construction, and much of it from original designs. It has been remarked before that it looks as though in the future the most valuable technical treatises will be the trade catalogues issued by manufacturers. While the book before us hardly fulfills this prognostication, yet, while it can hardly be regarded as a valuable treatise, it comes near to being so, but is, nevertheless, a very useful "reference book" on signaling apparatus, and in the present dearth of literature on that subject will do good service in place of what is now much needed—that is, a really good treatise on railroad signals.

BOOKS RECEIVED.

THE NEW OMAHA BRIDGE : A REPORT TO CHARLES FRANCIS ADAMS, PRESIDENT OF THE UNION PACIFIC RAILWAY COMPANY : BY GEORGE S. MORISON, CHIEF ENGINEER OF THE OMAHA BRIDGE. New York ; issued by the Company.

ON THE USE OF PETROLEUM AS FUEL IN LOCOMOTIVE ENGINES : BY THOMAS URQUHART. London, England ; published by the Institution of Mechanical Engineers. This is a reprint of the paper read by Mr. Urquhart to the Institution of Mechanical Engineers, and contains also the discussion on the paper.

SELECTED PAPERS OF THE RENSSELAER SOCIETY OF ENGINEERS, JUNE, 1889 : EDITED BY THE COMMITTEE ON PUBLICATION. Troy, N. Y.; published by the Society. The present number contains papers on Stand-Pipes, by Wynkoop Kiersted, and Notes on the Theory of Cantilever Bridges, by Charles McMillan.

CANADA, STATISTICAL ABSTRACT AND REPORT FOR THE YEAR 1888 : PREPARED BY THE DEPARTMENT OF AGRICULTURE, S. C. D. ROPER, COMPILER. Ottawa, Canada ; Dominion Printing Office.

ANNUAL REPORT OF THE COMMISSIONER OF PATENTS, FOR THE YEAR 1888 : BENTON J. HALL, COMMISSIONER. Washington ; Government Printing Office.

REPORT OF THE CHIEF OF THE BUREAU OF STATISTICS, TREASURY DEPARTMENT, ON THE IMPORTS, EXPORTS, IMMIGRATION AND NAVIGATION OF THE UNITED STATES, FOR THE QUARTER ENDING MARCH 31, 1889 : WILLIAM F. SWITZLER, CHIEF OF BUREAU. Washington ; Government Printing Office.

INTERSTATE COMMERCE COMMISSION : REVISED AND AMENDED RULES OF PRACTICE IN CASES AND PROCEEDINGS BEFORE THE COMMISSION ; ADOPTED JUNE 8, 1889. Washington ; Government Printing Office.

LIST OF BOARDS OF TRADE AND OTHER COMMERCIAL AND INDUSTRIAL ORGANIZATIONS OF THE UNITED STATES : BEING STATEMENT NO. 47 OF QUARTERLY REPORT NO. 3, SERIES 1888–89, OF THE BUREAU OF STATISTICS, TREASURY DEPARTMENT. Washington ; Government Printing Office.

NATIONAL ASSOCIATION OF BUILDERS OF THE UNITED STATES : PROCEEDINGS OF THIRD ANNUAL CONVENTION, HELD IN PHILADELPHIA, FEBRUARY 12–14, 1889. Boston ; issued by the Association, William H. Sayward, Secretary.

THE SCHOOL OF MINES OF THE UNIVERSITY OF MISSOURI CATALOGUE, 1888–89. Rolla, Mo.; issued by the University.

AUTOMATIC AND VARIABLE CUT-OFF BLOWING ENGINES FOR BLAST FURNACES, BESSEMER WORKS, AIR COMPRESSORS, ETC. Philadelphia ; Gordon, Strobel & Lareau, Limited, Engineers. This is an admirably illustrated catalogue of a class of engines called upon to do very difficult and exacting work, and requiring special knowledge and experience in their design and construction. It is of interest for that reason.

ABOUT BOOKS AND PERIODICALS.

THE last number of the BULLETIN of the American Geographical Society contains a continuation of the interesting article on the Portuguese in the Track of Columbus ; an article on the Hawaiian Islands, by Dr. Coan, and a long and interesting article on the Great Basin, the most distinguishing geological feature of the North American Continent, by Professor William H. Brewer. There is also the usual variety of geographical notes, home and foreign.

Among the articles in the latest number of the PROCEEDINGS of the United States Naval Institute are—An Outline of a Scheme for the Naval Defense of the Coast, by Captain W. T. Samson, and Domestic Steels for Naval Purposes, by Lieutenant-Commander J. G. Eaton. Other articles are on Collisions at Sea ; the Right of Way at Sea ; the Efficacy of Oil for Subduing the Violence of Waves ; the Cruise of the *Vandalia*, and a continuation of Notes on the Literature of Explosives.

Among the new books announced by JOHN WILEY & SONS are a Treatise on Ordinary and Partial Differential Equations, by Professor William Woolsey Johnson ; Submarine Mines and Torpedoes, by Lieutenant-Colonel J. T. Bucknill, Royal Engineers ; and Elements of the Art of War, prepared for the use of the cadets of the United States Military Academy, by Professor James Mercer.

Manual Training, which is receiving so much attention at present, is the subject of the first article in the August number of the POPULAR SCIENCE MONTHLY. This article is by Professor C. H. Henderson, of Philadelphia. Another suggestive article in the same number is on the Wastes of Modern Civilization, by Dr. Felix L. Oswald.

The JOURNAL of the Military Service Institution for July has two interesting articles on the higher military education—An American War College, by Lieutenant Arthur L. Wagner, and New Course of Instruction at Fort Monroe, by Captain W. E. Birkhimer. Other articles are on Mobilization ; on Infantry in the Field, by Lieutenant Wisser, and on Cavalry Gaits, by Captain Dorst. Translations include Mounted Infantry ; French Field Artillery, and the continuation of Prince Hohenlohe's papers on Infantry and Artillery.

The leading article in the July CENTURY is by Charles Barnard on the Inland Navigation of the United States. It contains some facts and comparisons of interest ; it is illustrated by views of a Western river boat, a Lake boat, the Hudson River steamboat *New York* and the new sound steamer *Puritan*. An omission which might be noted is the absence of any illustration of one of the great freight carriers which are fast replacing on the Lakes the type of steamboat pictured in the article.

The electrical article in SCRIBNER'S MAGAZINE for July is on the Telegraph of To-day, and is a history of the growth and improvement of the telegraph. It includes an account of the

duplex and quadruplex methods of telegraphing, and of the Phelps-Edison train telegraph system.

The Discovery of the Mississippi is discussed in the July number of the MAGAZINE OF AMERICAN HISTORY, by Henry Lee Reynolds, who makes out a strong case for Alonzo de Pineda as against the rival claims of De Soto and Cabeça de Vaca. Pineda was sent from Jamaica in 1519 to explore the Gulf of Mexico, and there seems to be little doubt that he entered the Mississippi and sailed up it a short distance.

In the OVERLAND MONTHLY for July, Henry S. Brooks writes of the troubles of American capital and business in Mexico, but doubts whether the annexation of that country to the United States is at all probable.

The latest addition to the list of railroad papers is THE CAR, a new monthly published in Philadelphia. A large part of its contents relate to street railroads, but steam railroads are not neglected, and there is a variety of news, gossip, and other interesting matter.

The WALL STREET JOURNAL is a new financial paper of the kind which has grown to be very useful and almost indispensable to a large class of persons. It is published in New York by Dow, Jones & Company, who, as proprietors of a financial news agency, have a reputation as enterprising and reliable gatherers of news. A special feature of this paper is the addition of a column to its table of bonds, giving the income which each bond quoted will yield to investors, at the price named in the latest quotations. This will be a great saving of time and trouble to those who consult the tables with a view to investment.

MECHANICAL TRAINING IN SCHOOLS.

To the Editor of the Railroad and Engineering Journal:

OWING to the great interest that is being shown all over the country in the question of the manual training of students, and the many advantages which have already shown themselves to be connected with this method of training carried on in connection with the ordinary school duties, I thought that the following sketch of the School of Mechanical Arts in connection with Griswold College, at Davenport, Ia., might not prove uninteresting to your readers.

Griswold College, proper, was an Episcopal Church college, and at present is only represented by St. Catherine's School for young ladies and Kemper Hall, a school for boys. Last September there was started, in connection with the ordinary course of instruction given at Kemper Hall, a course of instruction in what might be called Mechanical Arts. This department was put in charge of Mr. H. G. Sedgwick, a most accomplished mechanician. As I was to some extent instrumental in starting this work, I have followed it with considerable interest during the past year.

The idea is to have a course running through four years, which is about the time most of the boys are connected with the school. The age of the students varies from 11 to 17 or 18, the average being between 14 and 15 years. This course in Mechanical Training is not in any way intended to interfere with the regular school work of the student, but merely to give him some insight into the manner in which work is done, render him familiar with the different tools and methods of doing the work, and thus train his eye, hand, and mind to methods of accuracy which no other kind of training has yet been able to accomplish. Of course it is not intended to turn out finished mechanics, although some of the work that has been done during the past year by these young lads would put many of our professional mechanics to shame.

The machine shop of the school is very well fitted up with a 25 H.P. engine, a boiler, and various machine tools for the working of wood, iron, or steel, such as lathes, planers, shapers, drills, emery wheels, two forges, blacksmith's outfit, etc.

At the beginning of the year the boys were divided into two classes, according to their age. The smaller boys were put at some of the elementary forms of woodwork, learning the use of the plane, saw and hammer, together with elementary word-turning, scroll-work, pattern-making, etc. Students of the proper age were placed at once in charge of the different machine tools—for instance, one at a lathe, one at a planer, one at a shaper, one at emery wheels, etc. Each of these students was carefully instructed in the uses of the tools before him. The proper and improper methods of handling were both shown, he remaining at that tool for a few days until he thoroughly comprehended the reversing, stopping and starting, the proper position of the tools, the back-gear, different feeds, etc. The work done was simply the plainest kind of turning, planing, and grinding.

When they had fully mastered the use of these tools, they were shifted to others, thus bringing each student in contact with each machine in the room. This preliminary work occupied about three or four weeks. They next took up what they called "Preliminary Construction," each student having to make a plan on paper of some simple geometrical figure, such as the cube, the cylinder, the triangle, etc. They then took these plans and duplicated them in wood, thus opening an entirely new field to the young lads, and showing them the intimate connection between paper plans and wooden structures. After the plans had all been duplicated as perfectly as possible in wood, they were required to duplicate them in iron or steel, using for this purpose the proper machine tools. This work is exchanged among the different students until each of them has performed the requisite amount in a satisfactory manner. This work occupied the whole of the first term.

The second term opened with very much the same work, but each piece was now required to be made according to "gauge rule"—that is, the cubes were required to be of a certain definite size, the cylinders of a certain inside and outside diameter, the triangles of definite angles. All these were first drawn, and then duplicated in metal.

The third term was opened with simple construction. Starting with the five mechanical powers, the students constructed them in their simplest form, one student constructing a lever, another a wheel and axle, another a pulley, etc. This led up to simple combinations, such as a lever acting upon a screw, etc.

The steam-engine was now introduced, all the necessary castings being furnished, and the work of combination began. Each student was obliged to make complete plans of his engine, and during the last year each of the students constructed a $1\frac{1}{2}$ H.P. horizontal engine. This closes the work as far as it has been actually carried on in the school.

The second year will be devoted to more complex forms and combinations, speed and power service machinery, the determination of values and coefficients, and will end with the construction of electric motors and dynamos.

The third year will be devoted to pneumatic and hydraulic machinery, delicate combinations, and a start in the cutting of gearing.

The fourth year gear-cutting will be completed. Train-work, escapement work, graduations, and micrometer work will be taken up.

This constitutes the plan that has been laid out for the instruction in mechanical arts, the first year of which has been completed. During this first year there have been 26 students in attendance, ranging from 10 to 18 years of age. Each of these students has constructed an engine of $1\frac{1}{2}$ H.P., usually, although there has been one constructed of 4 H.P., which, upon trial, gave such excellent results as to speed, steadiness, etc., that it was purchased by the Iowa State University, for experimental use in the Testing Laboratory of the Engineering Department.

The time devoted to this instruction has been two hours a day for five days in the week. It has been found not to interfere in any way with the general standing of the students in their classes. Almost without exception those students that stood highest in their classes have taken the most interest and excelled in the department of Mechanical Arts, while other students who have never shown the slightest brilliancy in what is called "book-learning" have developed a wonderful ability in the machine shop, and have thus found occupation and have developed much latent talent, the possession of which neither they nor

their parents were aware of. All the students, without exception, have shown interest in their work, and the only trouble that has been experienced has been to keep them out of the machine shop and confine their work simply to the two hours that was required, rather than to make them attend these two hours.

Each day one of the students is put in direct charge of the 25 H.P. engine that runs the shop, and is responsible for it. Of course none of the students are allowed to touch any piece of machinery or any of the engines without having previously received full instructions from the director, or under his direction.

The physical health of the boys has been in no way interfered with, and a stronger, brighter, more interested set of boys it would be hard to find anywhere in the country than I saw the other day, when some 18 of them had their engines all connected with the boilers and each little engine was making 300 or 400 revolutions a minute.

The success of this mechanical department during the past year at the Kemper Hall School has been unmistakable, and its advantages to the boys, both in training, in habits of accuracy and in intellectual and physical development, have been very marked. They have been exceptionally fortunate in being able to have as many fine machine tools and as elaborate a shop as they have.

There is no reason why such departments should not be started in many other boys' schools, and if those interested in the education of boys could only see and appreciate the many advantages reaped by the boys during the last year, in this one little example of the teaching of mechanical arts, I have no doubt but that much more general use would be made of this branch of instruction.

C. D. J.

THE STRENGTH OF BEAMS AND COLUMNS.

To the Editor of the Railroad and Engineering Journal:

IN justice to myself, I ask space in your JOURNAL to reply to your notice of my "Strength of Beams and Columns," contained in your July issue. For a beginning you assert, "The new theory of beams presented in this work is developed from certain hypotheses for which the Author offers no justification, either experimental or theoretical."

First, as to the "theoretical justification." The breaking of a beam or column is in the nature of a power overcoming a resistance; this makes it a machine whose mechanical movements must be clearly understood. The load is applied, motion takes place as a result, the resistance of the material is developed, and equilibrium only ensues after all motion has ceased. In such a system of forces, the center of motion is necessarily the center of resistance. Now in the book referred to, the center of motion, the action of the power or load, and that of the resisting forces are clearly defined, and as these include all of the elements of strength, no more conditions could be imposed. The correctness of the hypotheses deduced from these mechanical conditions is fully sustained by the large amount of experimental data given.

As to the "experimental justification," there is not a formula in the book that is not illustrated by from two to ten examples taken from the records of Fairbairn, Barlow, Hodgkinson, Owens, Wode, the Watertown Arsenal Tests, and other trustworthy sources. The identity between the computed and actual results varies simply with the care with which the experiments were made. The variation that exists arises principally from a lack of exact knowledge of the compressive strength, for no two experimenters would make it the same for the same material. In the carefully made tests of the Watertown Arsenal, the computed and actual results are practically identical. I do not know your exact definition for "experimental justification," but the above list of experimenters is generally considered to about exhaust all available experimental data. Moreover, I make the assertion that you cannot find a single experiment that gives correctly the crushing and tensile strength of the material composing a beam; that the strength of the beam could not have been foretold, and that if there were any difference between the actual and computed tests the difference would be practically nothing.

The following fundamental principles, "founded on universal experience," and "all the text-books," lead to many embarrassing contradictions. You say, "It is a fundamental principle of mechanics that when a *free* body is acted upon by *two* forces whose directions are opposite, *motion* will ensue unless the forces are of equal intensity. This principle applied to the horizontal fiber-strains in a beam shows that the sum of the tensile stresses must be equal to the sum of the compressive stresses." The first part of your statement is ambiguous, but your application removes this. "Two forces of equal magnitude applied to the same body in parallel and opposite directions, but not in the same line of action, constitute what is called a *couple*; its tendency is to turn the body to which it is applied," and it would require something else besides the equality of the forces to prevent motion. This is a fundamental principle, and contradicts your fundamental principle. Besides, the principle stated contradicts the basis of the theory maintained by you, for it is claimed that the moment of resistance of a beam is the moment of an equal force stress couple that has *motion* around the *neutral axis*. Moreover, the application of the common theory contradicts its fundamental principles, for it is only in such beams, whose center of gravity and center of figure coincide, that this equality of the stresses is maintained. In the T-beams, with only one flange, and in the Hodgkinson beam, the tensile stress is not equal to the compressive stress. To illustrate this, refer to the example of a Hodgkinson cast-iron beam given by Professor Wood on page 163 of his Resistance of Materials. The position of the neutral line is given by him, and you can easily figure out that the tensile stress is 13.9 R, and the compressive stress 9.9 R —R being the Modulus of Rupture; for this example it equals 36,000 lbs., and makes the difference between the stresses 144,000 lbs. The stresses are not equal, and this contradicts the theory and your fundamental principle. Now, don't you think that this is a very poor "fundamental principle" that has to be abandoned in order to accommodate a mere change in the form of the section of the beam?

The principle that you desired to state is as follows: "In a balanced system of parallel forces the sum of the forces acting in opposite directions is equal; in other words, the algebraic sum of the magnitudes of *all* the forces, taken with their proper sign, is nothing, or zero" (Rankine's Civil Engineer, page 140).

From this you deduce

$$C - T = 0,$$

C and T being the sum of the tensile and compressive stresses respectively. Now I conceive this to be an erroneous deduction from the principle and a fundamental error, for it takes *four* stresses to establish this equilibrium, and you have imposed the conditions upon *one-half* instead of on *all* of them. The following is the correct equation:

$$(T - T) + (C - C) = 0.$$

Now, there is nothing in this equation that requires that $T = C$, but only that $T = T$ and $C = C$. The horizontal stresses being *directly* balanced—that is, tension balances tension and compression balances compression—we can impose upon them no other mechanical condition except the equality of their moments.

The principle stated applies to the equilibrium of a *free* body, but a beam is not such a free body, for it is forced to move or rotate transversely around a *fixed* center, with respect to which the moments of *all* of the forces must be in equilibrium. This fixed center cannot be a point within the beam, as it would thus cause the ends of a beam to rotate toward each other around a point within itself, which it is physically impossible for a rigidly connected body to do. Therefore the application of the principle that makes the horizontal stresses an equal force stress couple is erroneous, as it can only be in equilibrio with respect to a point half way between their lines of action.

I could say much more, but fear to trespass too much upon your space. However, I think that you will be convinced that the book deserves a more critical examination than you give it, even though it does apparently contradict all of the text-books and some fundamental principles.

R. H. COUSINS.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page 325.*)

CHAPTER LIV.

COMPARISON BETWEEN THE HAMMER AND THE PRESS.

Large ingots being often not very homogeneous, certain English and German engineers have claimed that forging with the hammer does not correct this want of homogeneity, because the action of the hammer is not felt thoroughly throughout the mass. If this action is very powerful, and is exercised in a very short time, the result is, according to the pretty theory of M. Tresca, that the flowing of the molecules not being produced under the desired conditions, the surface of the metal is changed, while in the hydraulic press the pressure being transmitted almost uniformly to all the layers of the molecules, it follows that they are all submitted to the same work, and thus all disarrangement of the structure is avoided.

We think that this claim is somewhat exaggerated, for after all nothing is less demonstrated than that a piece forged under the hammer under good conditions will have less resistance than if it had been forged in a hydraulic press, the dimensions of the ingot being the same in both cases.

Some engineers have sought to determine the pressure necessary to produce an effect equivalent to that of the shock or blow of the hammer on non-elastic material. They have gone so far as to find a formula after a series of experiments in which they measured or weighed the blow of a hammer-head arrived at the bottom of its fall.

We believe, however, that it is impossible in the full acceptation of the word to weigh or measure the effect resulting from the work of a body which falls freely.

1. On account of the inertia of matter.

2. Because the apparatus which must measure the effect is obliged to pass over a long path in a very short time, and there is a transformation of work with much absorption ; what we can obtain is, then, not the exact expression of the work transmitted.

3. If we use as a measure a comparative crushing force there must still be error, for the two causes given above, and also because there is more heat developed in the case of crushing by a blow or a shock—as we will see further on—than when a permanent or steady pressure is applied, and consequently there is more work absorbed.

4. The comparative method is also liable to error, because the effect obtained or work performed is not obtained in the same time by both processes.

When a body of a given weight passes through a certain space in a given time, there is an amount of force developed which can be expressed in kilogramme-meters, and which cannot be compared to the action of an inert body.

To sum up in a word, the work resulting from a blow struck at great speed cannot be compared in its effects with that resulting from a heavy mass moving at a low speed, although they may be equal in one sense.

Let us suppose for instance a hammer of 10,000 kgs. falling 2 meters ; the speed of the hammer at the moment when it strikes the forging will be

$$V = \sqrt{2gh} = 6.26.$$

The work produced at the moment of the shock will be

$$T = 10{,}000 \times 6.26 = 62{,}600 \text{ kg.-m.}$$

Admitting a piston speed in the press of 20 mm. per second, the power P should be

$$\frac{62{,}600}{0.02} = 3{,}130{,}000 \text{ kg.}$$

Then this pressure of 3,130,000 kg. should produce in one second an effect equal to that produced in two-thirds of a second by a hammer of 10,000 kgs., having a speed of impact of 6.26, the striking surfaces remaining the same, which is entirely contrary to the truth, taking, for example, the results obtained in England by presses of an inferior power.

In working metals hot it must be remembered that we cannot disregard the influence of the time consumed in producing a given effect, because of the enormous increase of resistance which results from the cooling of the metals, always very rapid at high temperatures, especially when the ratio of the radiating surface to the volume of the forging is large. This influence is especially felt in the case of the press, because the parts next to the press-head cool down very rapidly.

The resistance opposed by a body of metal to any change of form under the action of the hammer or the press cannot be deduced otherwise than by experience, and we have, therefore, made a series of trials in order to determine, if possible, the ratio of power between the hammer and the press, in different conditions as to temperature, quality of metal, and size of forging. Unfortunately, we can only describe these trials, for we have been entirely unable to deduce any formula, which will indicate fully the power of the press capable of producing the same effect as a hammer of a weight and stroke specified, or inversely. In the case of a body submitted to the action of the hammer or of that of the press, a change of figure is produced, which is the result of the displacement of the molecules of this body.

We are going to examine what are the changes produced.

1. If we take a heavy ingot and submit it to the action of a hammer which is too light for the work to be done, it will produce the result known to all hammermen—that is, the surfaces will spread out at the ends, while the central parts will remain intact, the ingot assuming the form shown in fig. 163.

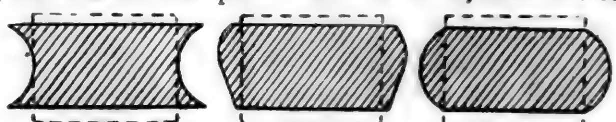


Fig. 163. Fig. 164. Fig. 165.

If, on the contrary, this same ingot is subjected to the action of too heavy a hammer, the central part will spread much more than the surfaces, and it will then take the form shown in fig. 164. This shows that it is necessary, above all, to proportion the effect or blow to the result to be obtained. This is a matter of practice, and the skillful hammerman judges what will be the best way of treating the metal, from its nature, from the size of the ingot, and from the form of the piece which he desires to obtain. The more complicated this form is and the more the changes of section are abrupt the greater will be the difficulty.

If now we take a similar ingot and submit it to the action of the hydraulic press until the decrease of thickness is the same as that obtained in the other two pieces under the hammer, it will take the form shown in fig. 165.

If we break each one of these three ingots through the middle we will see that the exterior layers of the first have a very much finer grain than those in the center ; that in the second case the same observation may be made except that the difference in grain between the center and the surface is somewhat less perceptible ; which shows that in this case the metal has been worked more at the heart, and consequently presents more homogeneity. The third is, on the contrary, of much finer grain at the center than at the surface.

We can, therefore, conclude from this that the exterior layers have been more compressed by the hammer than by the press, and inversely for the central layers.

An account of the experiments referred to, which presented some very interesting results, will be given in the following chapters.

CHAPTER LV.

EXPERIMENTS WITH THE HAMMER AND HYDRAULIC PRESS.

The experiments, of which notes are given below, were made with a hammer of 3,500 kg., and a hydraulic press made for forging wheels and having a power of 100 tons. It is to be regretted that this was the only hydraulic press

which could be used, for results somewhat different might have been obtained with one having a greater piston speed. The experiments will, nevertheless, serve as a guide to those who are interested in the question, and for this reason it has been considered useful to place them on record.

EXPERIMENT NO. 1 (figs. 166, 167, 168, and 169). Blocks

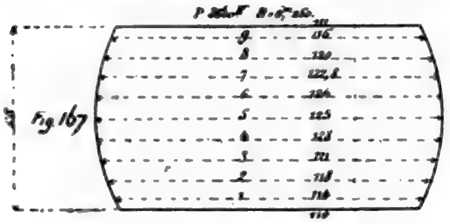


Fig 167

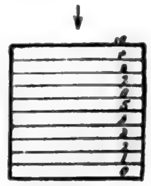


Fig. 166

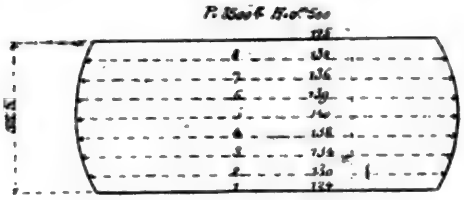


Fig. 168

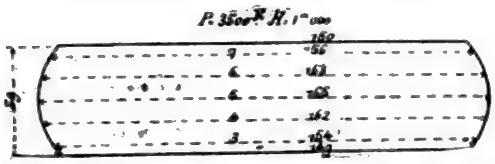


Fig. 169

of lead, from pig lead, cast into cylindrical ingots and then turned up to a diameter of 100 mm. and a height of 100 mm.

Circumferential lines parallel to the base and 10 mm. apart were traced on the cylinders, as shown in fig. 166, in order that the variation in each section might be traced.

1. First block, fall of hammer, $h = 0.250$ meter; thickness, $e = 68$ mm.; compression, $a = 32$ mm. This block is shown in fig. 167. No particular remark required.

2. Second block (fig. 168), fall, $h = 0.500$ meter. The lines 1 and 9 disappeared, becoming merged in the top and bottom lines; thickness, $e = 56.5$ mm.; compression, $a = 43.5$ mm.

3. Third block (fig. 169), fall, $h = 1.000$ meter; thickness, $e = 39$ mm.; compression, $a = 61$ mm. The lines 1, 2, 8, and 9 disappeared, all the other lines—3, 4, 5, 6, and 7—remaining parallel and almost equidistant.

Three similar blocks were then submitted to the action of the press until their thickness was reduced to that of Nos. 1, 2, and 3 above, respectively, the pressures required being 30 tons, 46 tons, and 79 tons; the changes of form in each case were substantially the same as under the hammer.

If now a coefficient K is sought which would give a ratio between this pressure and the work obtained by the fall of the hammer, we find:

$$K = \frac{P}{p \times h}$$

$$K = \frac{30{,}000}{3{,}500 \times 0.25} = 34$$

$$K' = \frac{46{,}000}{3{,}500 \times 0.50} = 26.3$$

$$K'' = \frac{79{,}000}{3{,}500 \times 1.00} = 22.5.$$

Taking the average of these three results, we have $K''' = 27.6$.

EXPERIMENT NO. 2 (figs. 170, 171, and 172). This was made with cylindrical blocks of steel, 100 mm. in diameter and 100 mm. thick, heated to a clear cherry red—about 1,000° Cent., or 1,832° Fahr.—the blocks being heated in the same furnace and submitted to the action of the two tools—hammer and press—at the same time.

1. First block (fig. 170), fall, $h = 0.500$ meter; thickness, $e = 82.5$ mm.; compression, $a = 17.5$ mm.

2. Second block (fig. 171), fall, $h = 1.000$ meter; thickness, $e = 73.5$ mm.; compression, $a = 26.5$ mm.

3. Third block (fig. 172), fall, $h = 1.500$ meters; thickness, $e = 65.5$ mm.; compression, $a = 34.5$ mm.

All the lines traced on the circumference remained visible, being parallel and almost equidistant, except Nos. 1 and 9, which nearly approached the top and bottom lines, Nos. 0 and 10 in the figures; all the layers increased in diameter, but more at the center than at top and bottom. The greatest diameter is found a little above the middle—that is, between the lines 5 and 6; moreover, the layers exposed to the direct action of the hammer were more ex-

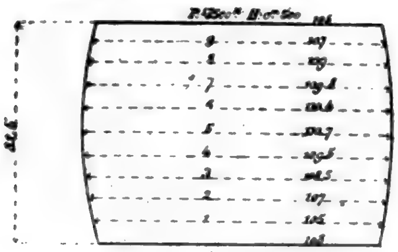


Fig. 170

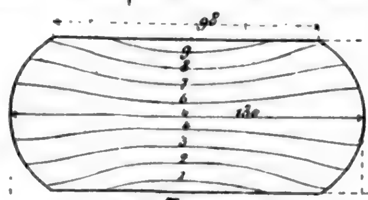


Fig 174

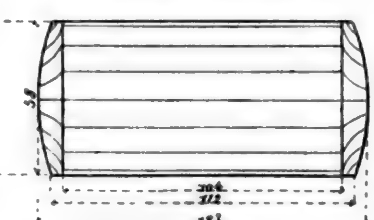


Fig. 176.

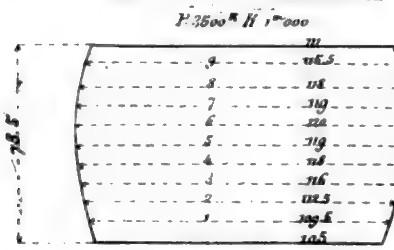


Fig. 171.

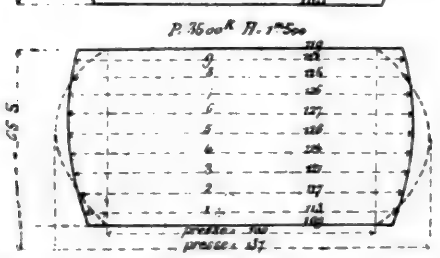


Fig. 172

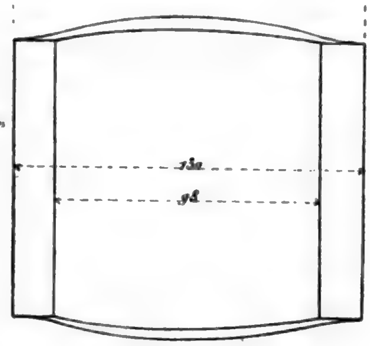


Fig. 175

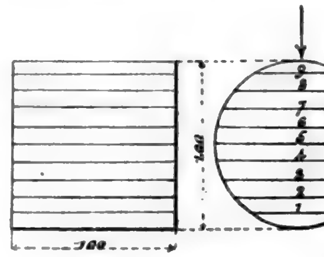


Fig. 173.

tended than the opposite ones, the difference of diameter in the case of the greatest fall—No. 3—being as much as 10 mm.

The three blocks submitted to the action of the press gave, for compressions equal to those tried under the hammer, pressures P equal to 42, 59, and 80 tons, respectively. This gives us coefficients K, equal to 24.0, 16.9, and 15.2, respectively, or an average of 18.7.

It may be noted that the surfaces in contact with the press were not modified, while those in the center were spread or enlarged considerably. In fig. 172 the dotted lines show the form assumed by the block under the press,

with the force of 80 tons, the full lines giving the form of the similar block under the hammer.

EXPERIMENT NO. 3 (figs. 173, 174, 175, and 176). This was made with a cylindrical block of lead 100 mm. diameter and 100 mm. high; weight of hammer, $p = 3,500$ kg.; fall, $a = 0.500$ meter; thickness, $e = 58$ mm.; compression, $a = 42$ mm. The horizontal lines 10 mm. apart traced on this cylinder (fig. 173) took after the blow the forms shown in figs. 174, 175, and 176.

A similar block under the press required a pressure of 40 tons to reduce it to the same thickness; the coefficient in this case was, therefore:

$$K = \frac{40{,}000}{3{,}500 \times 0.50} = 22.8.$$

The form of the block under the press was substantially the same as under the hammer.

The force required in the hydraulic press to obtain the same compression was 73 tons; the coefficient K is then as follows:

$$K = \frac{73{,}000}{3{,}500 \times 1.000} = 20.8.$$

In figs. 177, 178, and 179, the full lines show the form assumed by the block under the hammer, the dotted lines showing the form obtained under the press. It will be noted that with the press there was more increase of diameter at the center and less at the surfaces than with the hammer.

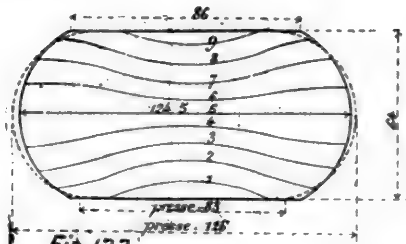


Fig 177.

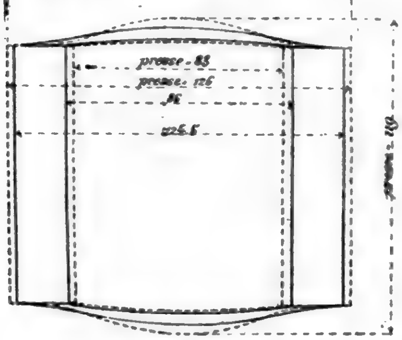


Fig 178.

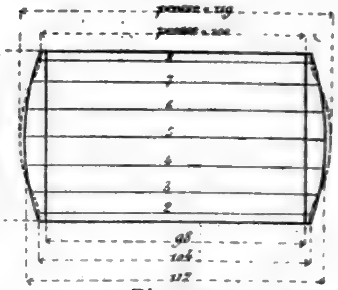


Fig. 179.

EXPERIMENT NO. 5 (figs. 180, 181, 182, and 183). This was made with a block of steel 100 mm. in diameter and 200 mm. long; in order to give a flat surface and even bearing, parallel surfaces 50 mm. wide were planed on the cylinder, as shown in fig. 180, these planed surfaces being 90 mm. apart. The block was heated to a clear cherry red. The hammer acted on this block through two steel blocks 50 mm. square, adjusted to the flat surfaces on the cylinder, fig. 180. The weight of hammer, $p = 3,500$ kg.; fall, $h = 1.000$ meter; thickness, $e = 53$ mm.; compression, $a = 37$ mm.

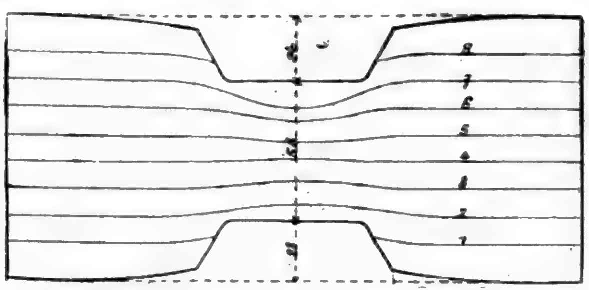


Fig. 181

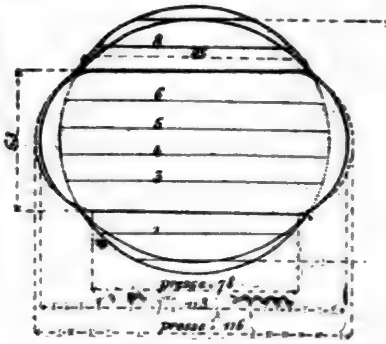


Fig. 183.

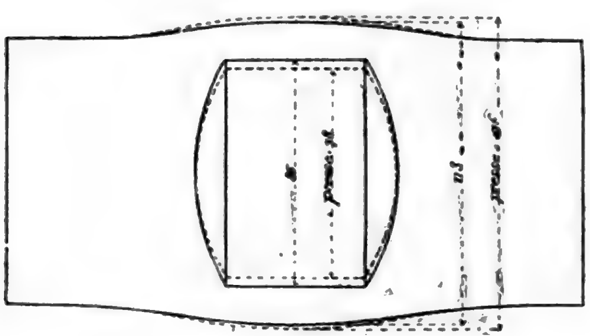


Fig 182.

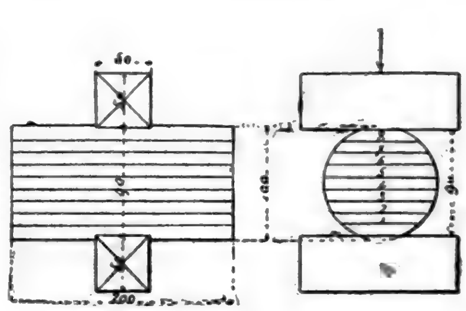


Fig. 180.

EXPERIMENT NO. 4 (figs. 177, 178, and 179). This was made with cylindrical blocks of steel, 100 mm. diameter and 100 mm. thick, heated to a clear cherry red, as in Experiment No. 2. The weight of hammer, $p = 3,500$ kg.; fall, $h = 1.000$ meter; thickness, $e = 64$ mm.; compression, $a = 36$ mm.

After the blow of the hammer the lines Nos. 1 and 8 disappeared, and the other lines, Nos. 2-7, followed the curves shown in figs. 181, 182, and 183.

A similar block tried under the press required a force of 53 tons to produce the same compression; the coefficient thus obtained is, therefore:

$$K = \frac{53,000}{3,500 \times 1.000} = 15.2.$$

It may be remarked that in this case—as in the fourth experiment—under the hydraulic press the surfaces were smaller and the central diameter larger than under the hammer. The form assumed under the press is shown by the dotted lines in figs. 181, 182, and 183.

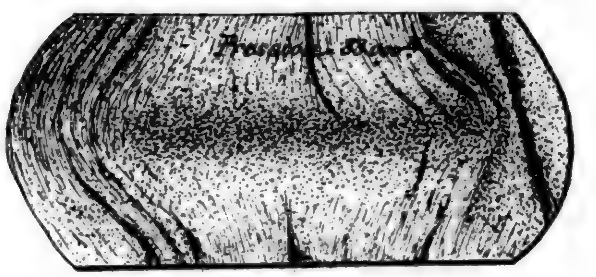
CHAPTER LVI.

REMARKS ON THE EXPERIMENTS.

All the experiments described in the preceding chapter were repeated a second time with substantially the same results. To make them complete they should have been repeated a greater number of times, and with varied forms and dimensions of blocks and temperatures; but this would have required an expenditure of time and money which could not well have been afforded.

Wt. of hammer, 3,500 kg. Stroke " 1.000 m. Fig. 184.

Wt. of hammer, 3,500 kg. Stroke " 1.500 m. Fig. 185.



Pressure, 83,000 kg. Fig. 186.

Pressure, 80,000 kg. Fig. 187.

Test pieces 5 mm. in thickness were cut after the experiments from the steel blocks, figs. 171 and 172, and then tried with acid. The condition of the fibers could then be observed exactly, and it has been reproduced in figs. 184, 185, 186, and 187.

Fig. 184 shows the condition of the steel block treated under a hammer of 3,500 kg., with 1.000 meter fall. Fig. 185 shows the condition of the steel block treated under the same hammer, but with a fall of 1.500 meters.

If we leave out of consideration the heavy black marks in the center of the block, which are the result of defects in the ingot, it will be seen that the grain is almost regular throughout, but slightly more fine at the exterior than in the center.

Figs. 186 and 187 show the steel blocks which had received the same compression under the press as the block in fig. 172.

In each of these figures it may be remarked that the exterior fibers have undergone considerable deformation, and that the grain is finer in the center than at the exterior.

From these different trials we can deduce this fact, that in a forging made under the hydraulic press the part which is most compressed and which is strongest is found in the center of the ingot, and if it is bored out—as in the case of large cannon—there is left only the exterior part, which has the least resistance. Now, it certainly appears as if, on the contrary, we should seek to obtain a forging the resistance and strength of which would be equal or nearly equal in all the parts. The hammer preserves the form of the ingot, and works equally on the exterior fibers, and therefore fulfills its object better than the press.

If, on the other hand, there have been faults and failures in making large guns and shafts of large size for marine engines, this must, in our opinion, be attributed to one or all of the following causes:

1. The large ingots from which the forgings have been made were originally worked under double-acting hammers, which, in consequence of their great speed of impact, have injured the cohesion of the steel.

2. The number of heats in bringing the ingot down to its final form has been too small.

3. The ratio between the finished section of the piece and the rough section of the ingot has been too low—in France there is taken generally a minimum ratio of 1:3 for large pieces, 1:5 for medium size forgings, and 1:10 for small forgings.

4. These pieces once forged have not been treated as they should have been—that is to say, that they have not been reheated. Now, the reheating is considered as an indispensable thing; its object is to equalize the interior tension and to give the forging higher elasticity and resistance, and this reheating, to be efficacious, should only be undergone after the forging. Some engineers, relying on this fact, even claim that all large shafts for marine engines should be hollow, since they would be more homogeneous, and the reheating would take place under better conditions.

The temperature of a body submitted to the action of a hammer being given, the maximum extension should always be less than the elastic limit, in order that the metal should not be injured in its structure and should not crack; in a word, the force of the blows which the metal can support is limited by the degree of elongation which its exterior fibers can support without breaking.

We have seen that the press has the inconvenience of cooling very rapidly the surfaces to be forged, on account of the prolonged contact of its cold surfaces, and that this does not take place with the hammer, with which the contact is, so to speak, instantaneous. In consequence the press could not be used for forging pieces with large surfaces and comparatively small thickness; this cooling being too rapid to permit the flowing of the molecules.

One great advantage of the press is that it does not act until the workman is sure that everything is properly arranged ; moreover, the piston can be stopped at any point and any accident or malformation prevented. This cannot be done with a hammer, and thus terrible shocks are often occasioned, which may injure the men working around it and break the crane which carries the forging.

When the press has produced on an ingot a compression corresponding to its maximum power, it can no longer exercise any action upon this piece without a new heating, while with the hammer we can with a second blow produce an additional compression, less than that of the first blow, and we can continue this as long as the temperature of the metal permits.

Presses intended for drawing out and forging ingots should therefore always be made very strong, since those of less power give opportunity for failures, and are in general less economical than hammers.

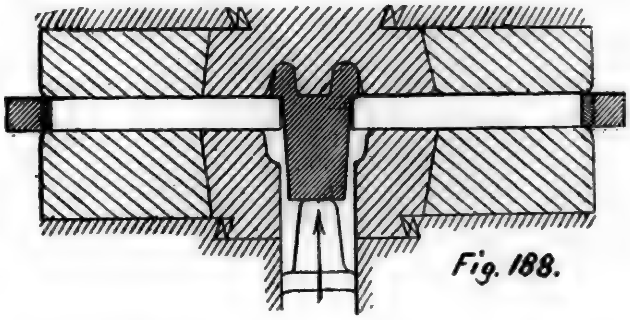


Fig. 188.

When the press is used to forge or stamp iron in closed dies—as in the Haswell or Brunon presses—the preparation of the pile should be made with the greatest care and with a small excess of metal, in such a way as to fill the die completely. These piles are first welded and rough-forged under the hammer into forms which will facilitate their final stamping into shape. The pressure then works on the whole mass and forces the metal to fill all the parts of the die, if its temperature is high enough ; the pieces must have a thickness so great that the cooling effect of the die will not prevent the flowing of the molecules.

In forging iron under the hammer in dies the cinder or slag can escape after each blow, while in the press it is imprisoned in the die and makes the work of finishing more difficult.

One advantage of the press is that the dies, not being exposed to shocks, last longer and their breaking is not to be feared. In working with closed dies the maximum pressure necessary to obtain good work is about 1,500 kg. per square centimeter. This is the power adopted by M. Brunon in forging the hubs of locomotive and car wheels, as shown in fig. 188. The compression pumps work at 100 atmospheres, and the piston of the press being 0.700 meter diameter, the surface is 0.3840 sq. m. The total pressure exercised will then be :

$$3.840 \times 103,300 = 396,672 \text{ kg.}$$

The mandril which penetrates into the die being 0.180 meter diameter, its area is 0.0254 sq. m., and in consequence the pressure per square centimeter exercised upon this mandril and which facilitates the flowing of the molecules from the center to the circumference is :

$$\frac{396,672}{254} = 1,560 \text{ kg.}$$

This pressure would be sufficient to stamp out hubs of 0.350 meter diameter.

In stamping out pieces of steel, as the resistance of that metal is greater than that of iron, and as it is worked at a lower temperature, the pressure per square centimeter should be twice as great, or about 3,000 kg.

In the Brunon press the upper, or male, die, which is worked by a screw, has a speed of 30 mm. per second and serves to close the lower, or female, die. The piston of the press then acts and raises with a speed of 40 mm. per second. The upper die stops as soon as it strikes the work, and it is at that moment that the piston of the press exercises its power and forces the hot metal into all the recesses of the die.

(TO BE CONTINUED.)

THE ENGLISH BATTLE-SHIP "BENBOW."

(From the London *Engineer*.)

THE accompanying illustration is from a photograph taken of the ship by Symonds & Company, photographers, of Portsmouth, England.

The *Benbow* is the most powerful completed vessel in our existing force of battle-ships. As Lord Armstrong happily remarked in his paper upon the new programme, which appears in this month's *Nineteenth Century*, they are advisedly called "battle-ships." For they cannot properly be designated "armored vessels," because the armor, as at present applied, only affords protection to the hydraulic loading gear, lifts, and other apparatus beneath the heavy gun positions, and partial protection to a strip along the water-line. In the *Benbow* we find a typical example of the *Admiral* class, with slightly greater displacement, more coal capacity, and a more important auxiliary armament than the remaining ships of this nature, and the two heaviest guns carried in any vessel in the world.

The ship is almost exactly similar to the *Anson* in her dimensions, which are as follows : Length, 330 ft. ; beam, 68 ft. 6 in. ; depth, 37 ft. 1½ in. Her draft is 28 ft. 4 in. ; displacement, 10,600 tons ; height of freeboard, about 10 ft. 6 in. ; and height of center of heavy guns above water-line about 20 ft. The twin propellers are worked by two sets of inverted three-cylinder compound engines, constructed by Messrs. Maudslay, Sons & Field. The two high-pressure cylinders are 52 in. diameter, and the four low-pressure cylinders 74 in. diameter, with a stroke of 3 ft. 9 in. The indicated H. P. is 11,500. Speed produced with forced draft, according to patent log, 16.75 knots. The coal capacity is for 1,200 tons, sufficient for 7,100 miles at a speed of 10 knots. The boilers are oval, 12 in number, arranged athwartships, each boiler being 12 ft. 4 in. wide, 14 ft. 1 in. high, and 9 ft. 11 in. long, and there are in all 36 furnaces. The total area of the heating surface is 20,440 ft. For working with forced draft there are eight fans of 5 ft. diameter, each driven separately.

The hull of the *Benbow* is divided into 190 compartments, and the magazines are at either end beneath the barbettes, connected with them by an armored ammunition trunk. There is room in them for 180 rounds of ammunition for the heavy guns. The double bottom of the ship is carried beyond the citadel bulkheads in both directions, and further protection is afforded against injury from below by a water-tight platform over the hold throughout the entire length of the ship, and between this and the under-water shot-proof deck are the boilers, engines, and magazines of the big guns. In effect, the method of subdivision is such that from the hold right up to the main deck there are practically three skins.

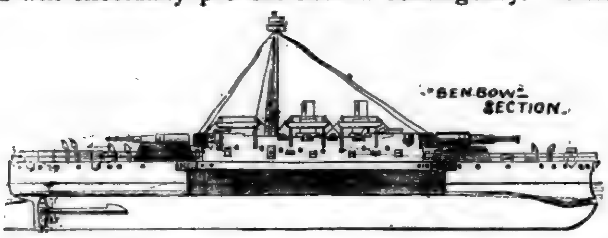
Protection against shot and shell is provided for by a belt of steel-faced compound armor, 18 in. thick, and about 150 ft. in length, so placed as to cover the sides amidships to a depth of 5 ft. below the load line, and to a height of 2 ft. 6 in. above the water. Over the part of the vessel so defended against horizontal fire there is also an armored steel deck, built up of two thicknesses of ½ in. plating and one layer 2 in. thick, making 3 in. in all. Below the 'midship protective deck there is placed over the engines and boilers a light steel splinter deck, ⅝ in. thick, to prevent interference with the forced draft and shut it off. Across the ends of the citadel are bulkheads of 18 in. and 16 in. armor. The sides of the ship above the upper deck, where the auxiliary batteries are placed, are of steel, only 1 in. thick. The sloping ends of this battery are, however, armored with 6 in. plate, to prevent a raking fire. This is the one fatal weakness of the *Benbow*, and of all her class. The 1 in. plate is just sufficient to explode a shell charged with high explosive, so that it will discharge its contents between decks, with what result can

FIRST-CLASS BATTLE-SHIP "BENBOW" ENGLISH NAVY.

BUILT BY THE THAMES IRON WORKS & SHIPBUILDING COMPANY.

be too easily anticipated. When the coal bunkers along the sides of the ship below the armored deck are filled they oppose a thickness of about 9 ft. of coal to the passage of shot. On the lower deck, in front of the horizontal water chamber—introduced to check the rolling of the ship by the movements of a large weight of water freely flowing from side to side—there are four deep water-tight tanks, to hold the ship's cables.

The two barbettes each cover a space on the upper deck about 45 ft. by 60 ft., the plan being pear-shaped, so as to leave room for the protection of the loading gear. They have steel-faced armor, 14 in. thick upon the exposed portions, and 12 in. thick behind the screens. An armored ammunition trunk, before mentioned, 10 ft. across, plated 12 in. thick, provides for the safe lifting of the powder and shot from the magazines below to within each barbette. But this armored stalk to the barbette does not permit the possibility of a shell bursting beneath the entire gun position and wrecking it. In the new barbette ships a heavily-armored redoubt will be constructed beneath the barbette, and will effectually prevent such a contingency. A steel



wire rope, working through the ammunition hoist, raises the projectiles for the heavy guns which weigh 1,800 lbs., and the charges, 960 lbs., in two portions. Overhead railways run the projectiles along from the magazines to the bases of the hoists.

The armament consists of two 111-ton steel breech-loading guns, one in either barbette, having a muzzle velocity of 2,100 foot-seconds, and a penetrative power into 32.5 in. of armor-plate at 1,000 yards. This would pierce the central citadel of the *Inflexible*, clothed with the thickest armor afloat. The auxiliary armament consists of ten 6-in. steel breech-loading guns, having a power of penetration into 10.3 in., which would dispose of either turtle-back deck plating, or any of the protective arrangements made for the lightly-armored cruisers now under construction. There are also fifteen 6 and 3-pounder Hotchkiss, and seven machine guns, and a proportion of torpedo discharge tubes. These last are fixed, as in all vessels of the *Admiral* class, on a special deck beneath the broadside batteries. They are capable of any amount of training, by means of the ball-and-socket joints with which they are worked in the sides of the ship.

On the spar-deck the *Benbow* carries a second-class torpedo boat, as well as a very large proportion of pinnaces and launches. The conning-tower is protected with 14-in. armor. The steadiness of this ship as a gun platform is very remarkable in ordinary weather. But the concentration of the armor plating so much toward the center, and the shortness of space between the gun positions, involves a bad distribution of the weights.

THE DRY-DOCKS OF THE WORLD.

FROM an article on Sheathed or Unsheathed Ships, by Naval Constructor Philip Hichborn, U.S.N., published in the last number of the *Proceedings* of the United States Naval Institute, we take the following interesting statements in relation to the dry-docks of the world :

It may be of interest to the general reader to know the extent of the "multiplicity of dock-yards" and private docks all over the world. It will, with the aid of a Mercator's Atlas, be easy to show how few and far between are the facilities for docking upon the ocean highways, where vessels of the United States Navy, especially cruisers, could go in to scrape and paint bottoms. It would, of course, be useless for this country to send its ships-of-war into European waters, where they would be picked up by overwhelming numbers of the enemy's ships, if the war was with either England or France.

The hostile operations would therefore be limited to within a few hundred miles of our own coast upon the Atlantic and the Pacific, and to an occasional brief cruise to the West Indies, while the paint upon the cruiser's bottom was still fresh. On the Atlantic Coast the Government docks are limited to Portsmouth, N. H., one floating dock ; New York, one stone dock, and a timber dock now building ; and at Norfolk, one stone dock, and a timber dock (building).

Of the projected docks no account has been taken in the following tabulated statement, which gives the distribution of the dry-docks of the world :

Austria	5	Russia	7
Belgium	11	Spain	13
Denmark	4	Sweden	13
France	53	Turkey	4
Germany	31	Africa	6
Great Britain	265	America	88
Greece	1	Asia	60
Holland	17	Australasia	12
Italy	13		
Norway	9	Total	616
Portugal	4		

Of the 166 docks in Africa, America, and Australasia, 87 are owned by the governments or citizens of European countries, as follows : Great Britain, 78 ; France, 6 ; Holland, 1 ; Portugal, 1 ; Spain, 1 ; total, 87. Of those owned by Great Britain 2 are in Africa, 15 in America, 51 in Asia, and 10 in Australasia.

Thus revised, the number of docks owned at home and abroad by the different countries is :

Nations.	At Home.	Abroad.	Total.	Gov't. Docks.*
Austria	5	...	5	2
Belgium	11	....	11	2
Denmark	4	....	4	2
France	53	6	59	32
Germany	31	....	31	8
Great Britain	265	78	343	42
Greece	1	....	1	1
Holland	17	1	18	2
Italy	13	....	13	8
Norway	9	....	9	3
Portugal	4	....	5	1
Russia	7	...	7	7
Spain	13	1	14	7
Sweden	13	....	13	6
Turkey	4	...	4	4
United States	60	....	60	6
Peru	1	....	1	1
Chile	2	....	2	2
Argentine Republic	4	....	4	....
Brazil	4	....	4	2
China	3	...	3	3
Japan	5	....	5	2
Total	529	87	616	143

From the foregoing table it appears that Great Britain controls or owns nearly 56 per cent. of all the dock-yards of the world. It has 10 in Australia, 15 in China, 36 in India and the adjacent islands. It owns 2 in Africa, 12 in Canada and British Columbia, 2 in the West Indies, 3 at Malta, and 1 at Demerara. The other 262 docks are within the confines of England, Scotland, and Ireland.

Let the reader follow the course taken by a cruiser from the Brooklyn yard, bound for the Pacific to protect American shipping or to chase and capture the enemy's vessels. The rendezvous of this cruiser would naturally be the Mare Island Navy Yard, so often referred to in each report of the Secretary of the Navy. Here the cruiser would call in to be docked for cleaning and painting, something quite necessary after a voyage of 15,000 miles. The cruiser would, of course, stop at Rio Janeiro to coal, and perhaps to dock, there being three docks of sufficient size to accommodate a ship of from 3,000 to 5,000 tons displacement. At Montevideo, 1,200 miles farther south, or 7,300 miles from New York, there are docking facilities for vessels not drawing over 18 ft. But after this there is no oppor-

* Included in total.

tunity to dock until San Francisco is reached, for all the docks on the west coast of South America, at Valparaiso and Callao, three in number, range only from 1,500 to 2,500 tons lifting capacity.

Once safe on the coast of California, the cruiser would have the choice of only two localities for docking to scrape and paint her bottom, namely, at San Francisco (or Mare Island) and Portland, 800 miles farther north, the latter within close proximity to the British naval establishment at Esquimault, Victoria, B. C. The docking facilities at Mare Island consist of one stone dry-dock, large enough to accommodate any war vessel except the large Italian armor-clads and those of England. Another dock at Mare Island built of timber, has been in use since 1853 and is rapidly decaying. The docks at San Francisco are the dry-docks at Hunter's Point, of a nearly similar capacity to that at Mare Island, and the hydraulic dock of the Union Iron Works, capable of lifting a vessel of about 3,000 tons displacement.

In Government docks the sole expense is that of the labor to prepare the dock and take the ship in and out. For a vessel like the *Chicago*, the cost would be between $300 and $400 for docking alone. To this sum must be added about $1,000 for scraping and painting, making a total of about $1,400. The actual cost of docking and painting the *Atlanta* is $1,250.

It is something quite different when a private dock is engaged. In Great Britain, great competition has brought the charges down to a minimum, but the docks in India, China, Australia, and on the Pacific Coast are very expensive. A few years ago, at San Francisco, the docking of the French ironclad *Triumphante* cost about $15,000 for five days, and when another French ship, the *Duquesne*, required docking in November last, the private dock wanted $5,000 for the first day and $2,500 for each additional lay-day. It would therefore appear that docking is an expensive operation, at least in the waters to which our ships-of-war would be confined in war time, and, moreover, that sometimes it might not be had at any cost, except at a few home ports.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

BY LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

(*Continued from page 322.*)

VII.—NAVAL ORDNANCE—CONVERTED GUNS.

THE work of converting our naval smooth-bore ordnance began in 1875, by the conversion of 11-in. shell guns into 8-in. muzzle-loading rifles, upon the same general system as has been followed in the land service—the insertion of a wrought-iron tube from the muzzle. The *Trenton*, which went to the bottom the other day in Samoan waters, was the first vessel to receive a complete rifled armament. A number of Parrott guns were also converted. In 1880 a 300-pounder, 10-in. Parrott was converted into a 9-in. breech-loader, by the insertion of a steel-jacketed, wrought-iron tube.

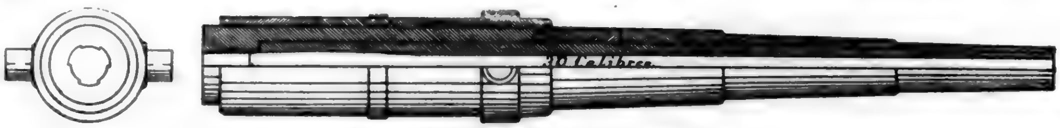
In 1882, when the rehabilitation of the Navy began, we find the rifled ordnance of the Navy to consist of one hundred and three 40-pounders, two hundred and seventy-seven 80-pounders, and fifty-one 180-pounders, all converted. Of this number twenty-six were breech-loaders.

The naval appropriation bill of August 5, 1882, authorized the building of four new cruisers, with their necessary armament of modern guns. Designs for 5, 6, and 8-in. breech-loading rifles were made, and later for guns of 10, 12, and 16-in. caliber. The first 6-in. gun was finished and turned over for trial in 1884. In the same year contracts were made with the English firms of Whitworth & Company and Cammell & Company, for the steel tube and jacket forgings for 8-in. guns. All the forgings for the smaller calibers, and the hoops for all calibers being obtained from American manufacturers.

The work of assembling and finishing began at the Washington Navy Yard, but its capacity being limited, contracts for a part of this work were made with the South Boston Iron Works and the West Point Foundry Association.

The first 8-in. Navy gun was finished in 1886. The year following the first 10-in. was turned over for trial.

Under the stimulus of liberal appropriations and the assurance of Government orders, the steel-makers of the United States are now, or soon will be, prepared to make all the forgings for guns up to 16-in. caliber. The Bethlehem Iron Company alone has spent a million and a half upon its plant for steel fabrication. We can congratulate ourselves in at last having reached a settled policy in the matter of gun construction, both in the land and naval service. That policy is essentially the same as has been adopted in France—to procure the rough forgings from private foundries and assemble and finish in Government shops. For the present, at least, and probably for some years to come, the necessities of the country and the limited facilities of the Government shops will lead to a very considerable part even of the latter work being done by private firms. The forgings delivered at Government shops are required to be oil-tempered and annealed. All work done at private shops is under the constant supervision of an ordnance expert.



8-inch Navy Rifle, Mark III Fig. 4.

In 1887 the Washington Navy Yard was transferred to the Naval Ordnance Bureau, and is now known as the Naval Gun Factory. When the present alterations are completed its yearly capacity will be equal to the completion of twenty-five 6-in., four 8-in., six 10-in., and four 12-in. rifles, or a proportionate number of other calibers.

The 14-ton, 8-in. Navy rifle of the last model may be taken as a type of naval ordnance construction, the details of which are shown in fig. 4. (It should perhaps be said that in plates given in these articles no attempt has been made to draw them to a common scale.)

With the beginning of the present year the United States possesses, in the way of high-power naval ordnance, actually finished, two 5-in., twenty-four 6-in., eight 8-in., and three 10-in. steel breech-loading guns, all made of open-hearth steel.

The endurance and ballistic qualities exhibited by these guns have been very satisfactory, and they are believed to be, in this respect, the equals of any guns of like caliber made abroad. But they have, we believe, one very grave defect, and that is in the matter of breech-mechanism. Both Army and Navy guns alike have the French, or interrupted-screw fermatures. Mention has already been made of the defects and dangers of this system. The fact cannot be too strongly emphasized that it has been a failure from the beginning. Our own brief experience points in the same direction. The accidental spiking of one of our new Navy guns before it left the workshop; the recent blowing out of the breech-block of one of our new breech-loading mortars at Sandy Hook; the complaints as to "sticking" in our field-guns, are but the beginning, we believe, of greater and more serious accidents. One of our own service papers, speaking on this subject, says: "When French field-guns unbreech even with blank cartridges, and then the heaviest guns either unbreech, or, when this defect has been corrected, the whole breech is blown off in ordinary service firing, it may reasonably be held that the system is at fault through inherent weakness, and, being unsafe, must at once be condemned out of hand."

It should be said, however, that our application of the screw fermature is an improvement on the French construction. As applied by them the seat of the breech screw is in the gun-tube itself; in our construction, both Army and Navy, the jacket carries the breech mechanism. While this reduces the danger it does not do away with the other objections that have been urged against the system.

The Board on Heavy Rifled Ordnance, created by the Act of 1872, recommended the Krupp breech-loading system. As has been stated, an 8-in. and an 11-in. converted breech-loading rifle, with the Krupp fermature, were tested in October, 1881. The 8-in. burst tangentially at the 127th round, the gun flying into many pieces, showing general weakness of metal; the 11-in. burst at the 18th round, fracture taking place at the junction of the breech-block slot with the powder chamber. The Board reported the accident due to "an inferior quality of steel in the breech-receiver." So far as can be seen there was nothing in these trials to condemn the system, yet when the designs for the new built-up guns were made adherence was given wholly to the French screw, and has ever since been persisted in.

VIII.—WIRE-WOUND GUNS.

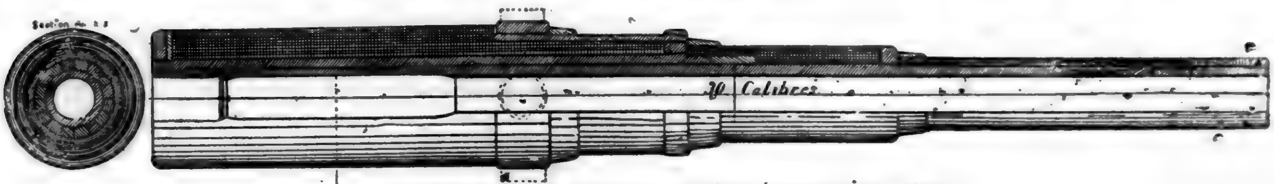
Another system of gun construction, which is about to receive trial in the United States, is that of wire-wound guns. The possibilities in this method of construction seem so great that it is worthy of mention, although still in an experimental stage. Generally speaking, the system consists in winding about the body of the gun layers of steel wire, under a known tension. The result, so far as concerns the inner tube, or bore of the gun, is to put it in a state of initial tension, under exactly the same conditions as when the piece is built up in the ordinary way by shrinkage. As it is possible to regulate the tension of the wire during the process of winding with exactness, it can be readily seen that almost any degree of initial tension for the inner portions of the gun can be obtained. The great defect in all guns of this construction is the want of end, or longitudinal strength.

This method of strengthening guns by winding the body with steel wire was first proposed to the British War Office, in 1855, by Mr. James A. Longridge. After some experiments, which demonstrated that while great circumferential strength was obtained, there was an equally great lack of longitudinal strength, the idea was, for the time, abandoned. Sixteen years later (1871) Lieutenant Schultz, in France, revived the idea, and a gun was constructed in which the body, a steel tube, was wrapped with steel wire, and encased in a wrought-iron jacket. Longitudinal strength was provided for by 12 long bars of steel set up between two bands shrunk over the jacket, one carrying the trunnions and the other enclosing the breech mechanism. The gun burst at the first fire, owing, it is said, to the unequal tension of the longitudinal bars. Other trials were made with cast-iron bodies, tubed with steel as far as the trunnions, and wrapped as before. In the later constructions the longitudinal bars were abandoned and end strength obtained by a jacket shrunk on over the wire, the jacket in front hooking over a band already shrunk on the gun, and at the rear being notched into the band containing the breech mechanism. Experiments in France have been carried on interruptedly since, with a gradual improvement in the methods and material employed. In 1886 a 13.3-in. wire-wound gun was finished for the Navy, from which an initial velocity of 2,300 feet-seconds was obtained.

Some years ago Sir William Armstrong took up the idea of wire-wound guns in England, which had been abandoned by Longridge, and manufactured several experimental pieces, and obtained results so satisfactory that this system of construction promises to obtain a secure footing in that country. A 10.2-in. gun was first manufactured, in which longitudinal strength was obtained by the disposition of some of the wire lengthwise around the tube. Armstrong has also manufactured a 6-in. gun in which a jacket is made to provide for longitudinal strength, the wire wrapping being expected to bring only circumferential strength.

The Royal Gun Factory has also taken up the subject and designed a system for experiment on a large scale. Longitudinal strength is obtained by means of segmental hoops of steel placed between the layers of wire. With a 9.2-in., 19-ton gun they have been able to use a charge of powder almost equal in weight to the projectile. A 375-pound charge threw a 380-pound shot with a muzzle velocity of 2,520 feet-seconds.

The Russians have also turned their attention to wire construction, and something over a year ago their first gun, constructed at the Aboukoff Steel Works, on Mr. Longridge's principle, was successfully tested. The gun is 6-in. caliber, 35 calibers in length, and has its steel tube wrapped for a little more than half its length with steel ribbon wire, which has a cross-section of 0.252-in. wide and 0.059 in. thick. Up to last reports this gun had been fired 300 rounds. The maximum velocity obtained was 2,150 ft., with pressure of less than 16 tons.



Woodbridge's 10-inch Steel Wire-wound Rifle. Fig. 5.

In the French construction round wire is used, of two sizes, for large and small calibers, while the English use ribbon wire. A patent has been recently obtained in England for a peculiar form of corrugated wire for gun construction. The exterior of the gun body has a corrugated surface. Into these corrugations the first layer of wire fits. Each layer of wire fits into the corrugations of the preceding one. The last layer has a flat exterior surface which gives a smooth exterior to the gun. The grip of the corrugations is expected to give the necessary longitudinal strength.

In the United States Longridge's claim to priority in the idea of wire-wound guns is disputed by Dr. W. E. Woodbridge. Dr. Woodbridge's plan was brought forward in 1850, or five years before Longridge's plan was submitted to the British War Office, and to him undoubtedly belongs the honor of the invention.

Woodbridge's system of wire-wound guns differs from that of Longridge's in that the wires, after being wound, are soldered together by immersing the gun in a bath of melted solder, the object of the solder being not only to give longitudinal strength, but also to prevent the unwinding of the wire in case a strand were cut by a hostile shot or otherwise. A 10-in. gun of this description was finished at the Frankford Arsenal in 1876 for trial. Square wire was employed, wound upon a solid steel core, which was afterward bored out to the required diameter, leaving a thin tube to form the bore of the finished gun. The piece failed during test from longitudinal weakness, after having been fired some 90 odd rounds with moderate charges.

The Heavy Ordnance Board, organized in 1881, recommended the further trial of the Woodbridge system. Under this recommendation a 10-in. cast-iron body, wrapped with wire, and one of steel of the same caliber are now in course of construction by the Army Ordnance Department, at the Watertown Arsenal. The cast-iron gun is well along toward completion. In this gun the wire has a square cross-section of 1.5-in. with rounded corners, and is wound with a uniform tension of 41,000 lbs. per square inch. The wire is supposed to have a tensile strength of 160,000 lbs. per square inch, and an elastic limit of 100,000 lbs.

The details of construction of the 10-in. steel gun are shown in the accompanying cut, fig. 5. Longitudinal

strength is obtained by a layer of long, square steel bars, with a cross-section of 3.43 in.

In 1882 two 6-in. wire-wound naval guns were authorized. Their construction was begun at the Washington Navy Yard, but has never been completed.

The advantages claimed for this method of construction are that a wire-wound gun can be completed in much less time than a built-up gun of the same caliber; that they are cheaper; possess greater strength, and afford a saving of some 25 per cent. in the weight of the finished piece.

IX.—RAPID-FIRE GUNS.

Within the last two years what are known as rapid-fire guns have reached a stage of development, both as regards weight of projectile and velocity, as to entitle them to be classed as high-power ordnance.

The real prototype of the rapid-fire gun was the well-known French *mitrailleur*, of which so much was expected and so little realized in the Franco-German war. From the machine gun, firing ordinary small-arm ammunition, and which automatically feeds, loads, fires, and ejects the empty cartridge cases to the revolving cannon, almost identical in construction and in manipulation, except that it uses heavier ammunition, and does not always fire automatically, the step was an easy one, and was brought about by the advent of the small, swift torpedo boat, against which the heavy, slow-firing guns of armor-clads gave but poor protection, and placed the heavier war-ship at the mercy of a lively but insignificant foe. The revolving, or machine cannon, firing projectiles of from one to four pounds in weight at the rate of from 20 to 80 shots per minute, with sufficient power to penetrate the sides or the armor-plating of these agile craft restored the equilibrium.

The rapid-fire gun differs from the revolving cannon or the machine gun in that each round, containing projectile, charge, and the fulminate for its ignition, is contained in a metallic case and must be handled separately. It is automatic only in the ejection of the empty cartridge-case and the cocking of the piece by the opening of the breech after firing. Beginning with the 3-pounder gun the growth has been rapid, until we have reached a stage when the weight of projectile and its power of penetration entitle the larger calibers to be classed with high-power ordnance.

Of guns that may be so classed there are the 36 and 100-pounder Armstrong; the 33-pounder Hotchkiss, and the 40 and 66-pounder Krupp. The 36-pounder Armstrong (caliber 4.72 in.) with a 12-pound charge and a 45-pound projectile, has given a muzzle velocity of 2,380 ft. per second, capable of penetrating some $9\frac{1}{2}$ in. of wrought-iron, and has a rapidity of fire of 12 shots per minute. It has fired 10 shots in 47.5 seconds. The 100-pounder (caliber 6-in.) has a 45-pound charge, a projectile of 110 pounds, which will penetrate $15\frac{1}{2}$ in. of wrought-iron, and can be fired 8 times per minute. The 33-pounder Hotchkiss (caliber 4 in.) uses a 12.5-pound charge, a 33-pound projectile, and has given a muzzle velocity of 2,034 feet-seconds, with a penetration of 10 in. The Krupp 10.5 and 13 centimeter guns, with projectiles of 40 and 66 lbs. respectively, can be fired from 12 to 15 times per minute, but the published accounts of their capabilities show a velocity and penetration considerably less than those given by either the Armstrong or Hotchkiss rapid-fire guns.

The employment of revolving cannon and rapid-fire guns as secondary batteries to men-of-war has obtained for several years. The development of the rapid-fire gun has now made it possible to employ them as main batteries for unarmored cruisers and vessels of the smaller type. The Italian cruiser *Piemonte*, built last year by Sir William Armstrong, carries six 4-in. and six 6-in. rapid-fire guns in main battery. All the later types of English cruisers are to be provided with this class of guns. As they have a rapidity of fire of from four to six times that of the ordinary breech-loading cannon of like caliber, the immense gain of such an armament is apparent. At Suakim, in December last, the rapid-fire guns on the *Racer* and *Starling* did splendid service in seconding the English attack.

The breech mechanism of rapid-fire guns merits a word of description. The Hotchkiss may be taken as a typical arm. In it the breech-block belongs to the wedge system, working in a vertical slot and falling downward of its own weight, exposing the bore. The block itself is rectangular in its cross-section with rounded corners. The front of the block is perpendicular to the axis of the bore, the rear face slightly conical. The breech-block is worked by means of a crank, with handles pivoted on the right side of the piece. It carries the firing mechanism. By pulling the crank-handle to the rear the block is disengaged from its seat and falls of its own weight This movement of the crank-handle cocks the hammer, and the falling of the breech-block actuates an extractor for throwing out the empty cartridge-case. The block is arrested in its downward movement by a stop-bolt screwed through the left side of the breech and into a slot cut in the left side of the breech-block. The piece is fired by means of a lock and hammer like those used on an ordinary rifle, and, like it, is provided with a trigger and trigger-guard, and a pistol grip.

The mechanism of the Krupp rapid-fire guns is very similar to that just described, and differing only in unimportant details. The Armstrong guns of this class use the ordinary interrupted screw, made conical, however, to facilitate the opening and closing of the breech. Instead of a hammer and firing-pin, these guns are fired by an electric primer in the base of the cartridge. The circuit is closed by means of a pin in the breech-block, so arranged that contact cannot be made except when the block is closed and secured in position.

It seems likely that the limit of caliber of these guns has about been reached. It has been questioned whether a projectile heavier than one man could easily lift would not nullify the advantages claimed for this class of guns. With the 100-pounder Armstrong gun a round of ammunition can be handled by two stout cannoneers. Beyond this weight it seems difficult to go, since any additional increase would necessitate the employment of mechanical means for handling the ammunition, which would then give them little, if any, advantage over an ordinary breech-loader.

The 6-pounder Driggs-Schroeder gun, the invention of two United States naval officers, has recently been tried at the Naval Proving Grounds, with such results as to give promise that it will be a very successful rival to other systems. Designs for a 5-in. gun are in preparation. The advantages claimed for this system are the extreme lightness of the breech mechanism—its weight being but about half that of the Hotchkiss—and the fact that it is simple and entirely protected by the breech-casing from rain and dust, the opening being from underneath.

The entire main batteries of the three 2,000-ton steel protected cruisers, authorized by the last Congress, are to be of rapid-fire guns—two 6-in. pivot and eight 4-in. broadside guns for each, besides their secondary batteries of 3 and 6-pounder rapid-fire and Gatling guns.

In following the development of the modern high-power gun no mention has been made of many of the numerous designs and systems of construction proposed by private firms and individuals both here and abroad. The list of those which have been unsuccessfully tested in the United States is a long one. Hitchcock, Mann, Sutcliff, Thompson, Wiard, Atwater, and Lyman-Haskell are names familiar in connection with ordnance experiments during the past 25 years. Of them all the Lyman-Haskell seems to be the only one which still claims sufficient merit to warrant a suspension of judgment. This is a multi-charge gun, in which the charges, arranged in a series of pockets along the bore, are successively exploded behind the projectile as it passes out of the piece. This system has had many trials, and a large amount of private capital has been expended upon it. Whether its failure has been due to poor material in the guns, or to a defective system of rifling, as is claimed by Mr. Haskell, or to inherent weakness of the system itself, will have to be determined by further experiment.

It is undoubtedly true that the efforts of private individuals and firms in the line of ordnance invention have been received by our official gun-makers with indifference, if not hostility. The success of Whitworth in England and Krupp in Germany shows what can be done by private enterprise in the line of ordnance invention and construc-

tion. In the first instance success was attained in spite of official discouragement and opposition ; in the second Government aid and encourgement have been freely given.

Whether or not prejudice has operated unfairly against private enterprise in this direction in the past, it is quite certain that under present conditions there will be "a fair field and no favor."

(TO BE CONTINUED.)

A FRENCH COMPOUND LOCOMOTIVE.

(From the *Revue Generale des Chemins de Fer*.)

An application of the apparatus invented by M. de Landsee was made in November, 1885, on a locomotive of the Northern Railroad of France, under the direction of M. Banderali, Chief Engineer of Material and Traction, to whom the test was committed, by the Engineer-in-Chief, M. E. Delebecque. The engine in question was one of those used for running light trains. This condition was necessary so that it might be run at all times with direct admission of steam to one cylinder only.

Engine No. 79, to which the de Landsee apparatus was applied was an old passenger engine, with four wheels coupled, which had been changed to a tank locomotive for the tramway-train service. Its principal dimensions are given in the table below :

Grate surface....................	9.47 sq. ft.
Heating surface, fire-box..........	51.67 " "
Heating surface, tubes............	726.70 " "
Heating surface, total.............	778.37 " "
Capacity of the boiler, water.......	61.80 cub. ft.
Capacity of the boiler, steam.......	46.61 " "
Diameter of cylinders.............	15 in.
Stroke of cylinders................	22 "
Diameter of driving-wheels........	68½ "
Diameter of leading-wheels........	41 "
Weight of engine in running order.	67,000 lbs.
Weight on driving-wheels.........	46,050 "
Maximum theoretic tractive effort..	5,122 "

The total weight of engine given above includes the tank full of water and 1,100 lbs. of coal.

In the accompanying illustrations fig. 1 is a general elevation of the engine ; fig. 2 is a front view, and fig. 3 a plan of the smoke-box, showing the arrangement of the steam and exhaust-pipes ; fig. 4 is a section of the steam-chest, showing the position of the valve when steam from the boiler is admitted to both cylinders, and fig. 5 is a section showing the position of the valve when steam from the boiler is admitted only to the high-pressure cylinder. It must be understood that the de Landsee apparatus is an arrangement by which the engine is worked on the compound principle with the ordinary cylinders—that is, with two cylinders of the same size. Steam can be admitted

Fig 2.

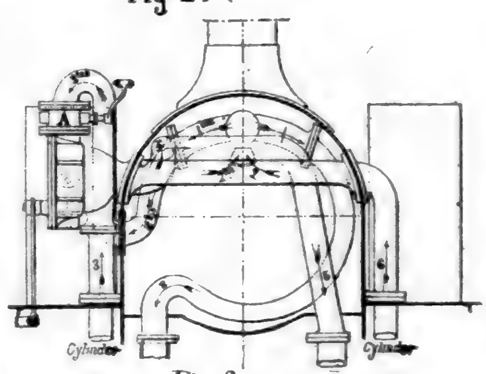


Fig. 4

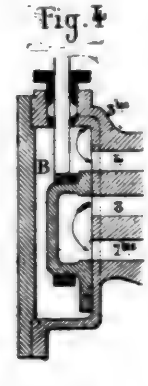


Fig 3.

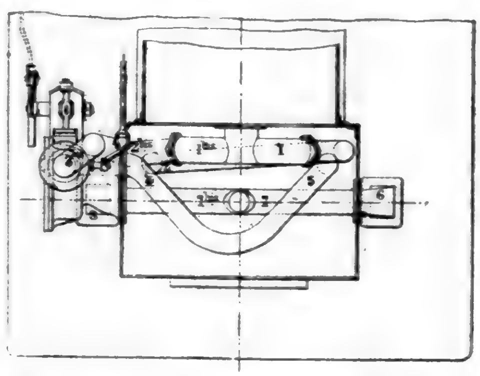
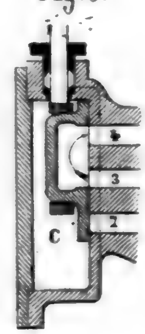


Fig. 5.

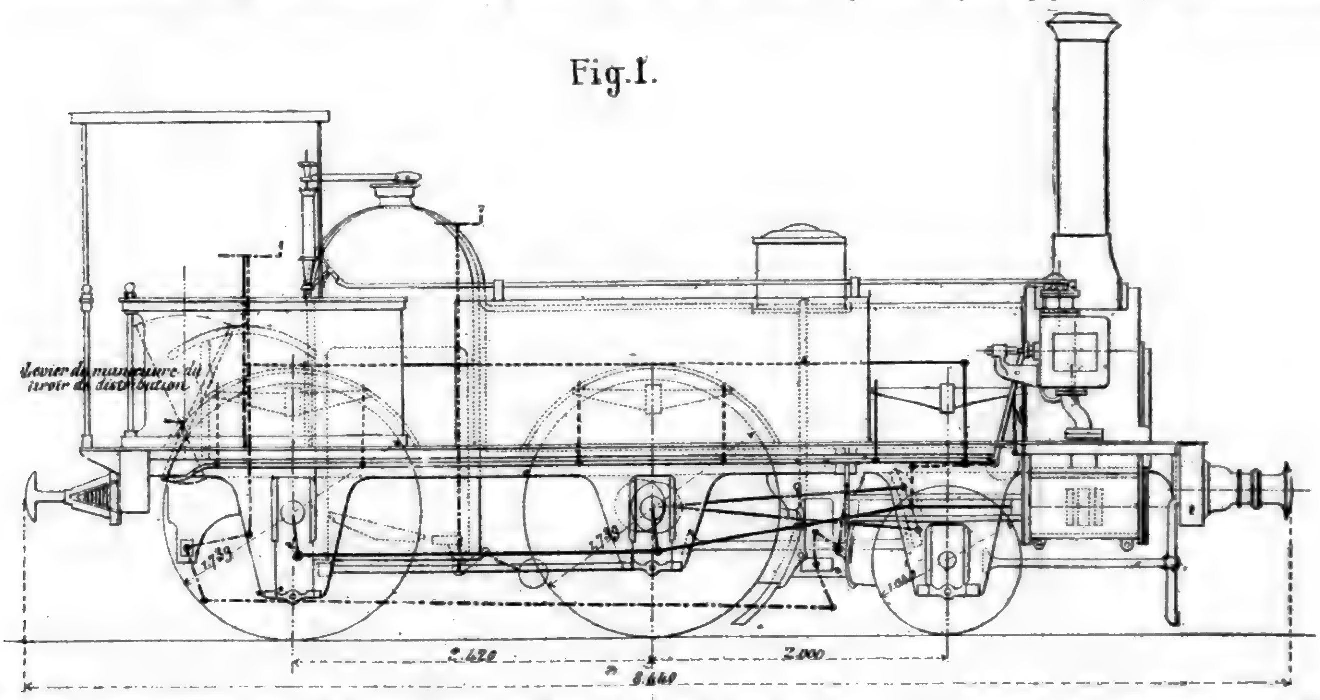


from the boiler to both cylinders or to one cylinder only, at the option of the engineer, the arrangement by which this is effected being shown in figs. 2 and 3.

When it is desired to admit steam from the boiler to both cylinders the valve *A*, fig. 2, is open and the distributing valve is in the position *B*, fig. 4. Steam is then admitted to the right-hand cylinder by the pipe 1 2, and to the left-hand cylinder by the pipe 1′ 2′ 3′, the distributor and the pipe 4 5. The exhaust takes place through the pipe 6 7 for the left-hand cylinder and through the pipe 3, the distributing valve and the pipe 7′ for the right-hand cylinder.

When steam from the boiler is admitted only to the high-pressure cylinder the valve *A* is shut, and the valve in the

Fig. 1.



steam-chest is in the position *C*, fig. 5. Steam is then admitted into the right-hand cylinder by the passage 1 2, and escapes by the passage 3 in the interior of the distributing valve; it then passes into the left-hand cylinder through the pipe 4 5, and from that cylinder is exhausted into the chimney by the pipe 6 7. The valve *A* may remain open when the engine is running compound, the distributing valve closing the admission to the left-hand cylinder.

The engine was put in service on the line from Lille to Tourcoing in July, 1886. On this line the tramway trains are usually composed of a single 8-wheeled car, weighing

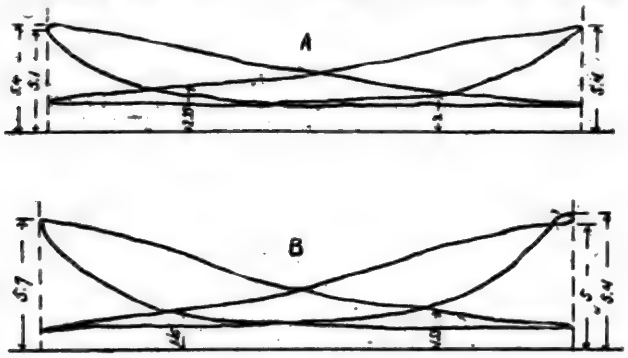


Fig. 6.

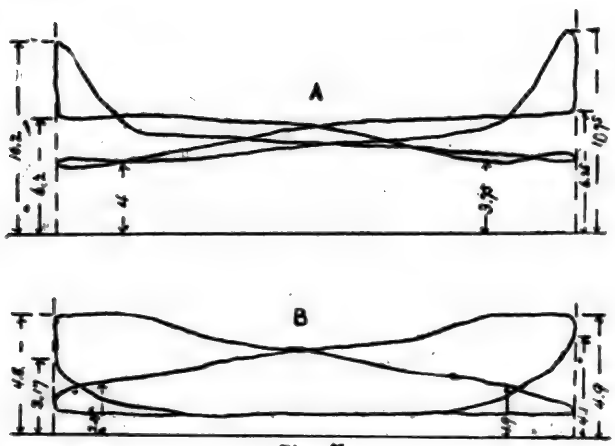


Fig. 7.

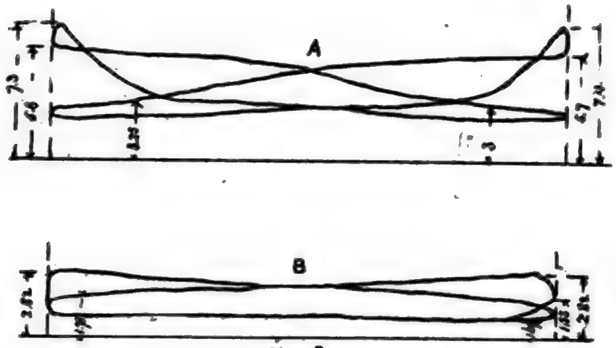


Fig. 8.

about 16 tons. This light load and the level character of the line permitted the constant use of the single admission; it was necessary to admit steam direct to both cylinders only on starting and then for but a few turns of the wheels. M. de Landsee did not think it necessary to change the arrangements of the machine in such a way that the admission should be always the same for both cylinders. The inconvenience of this arrangement was shown in the first diagrams taken from the machine; while running with direct admission to the high-pressure cylinder only and cutting off at from 50 to 60 per cent. of the stroke, the compressions in that cylinder were as high as 125 to 140 lbs., although boiler pressure was only about 72 lbs.; moreover, the work indicated in the two cylinders was different.

Under the advice of M. de Bousquet the distribution of the two cylinders was made independent by adding a special reversing arrangement to the left-hand cylinder, and an invariable rule was adopted of leaving this at its maximum admission, 85 per cent. This rule was established by analogy with the ordinary compound engine; in this case the two cylinders being equal, the admission to the second cylinder should be made during the entire stroke. This new arrangement, while reducing the counterpressure of the first cylinder, made a much better division of the work and decreased, at the same time, the pressure in the admission cylinder.

The accompanying cuts, figs. 6, 7, and 8, show three series of diagrams taken from the cylinders under the three conditions in which the engine can be run. In each case *A* is the diagram from the right-hand cylinder, and *B* that from the left-hand. Fig. 6 shows diagrams taken when the engine was running with steam from the boiler admitted to both cylinders. Fig. 7 shows diagrams taken when the engine was running compound, but with an equal opening for each cylinder. Fig. 8 gives diagrams taken while the engine was running compound, with an admission to the left-hand cylinder for 85 per cent. of the stroke.

These three groups of diagrams show about the same power developed for each revolution of the wheel. An indicator of the Deprez system was mounted at each side of the engine, and this arrangement permitted diagrams to be taken simultaneously from both cylinders. Some tests for coal consumption were made on this engine both for running compound and in the ordinary way, but the trials were too short to enable engineers to give exact figures, which would not be open to criticism. It may be said, however, that the engine, drawing light trains on a level line, and running on the compound principle, burns from 10 to 12 per cent. less fuel than when running in the ordinary manner. This, however, only applied when the distribution of steam to the two cylinders was made independent, as stated above.

Although, from a certain point of view, the results were favorable, the use of this system has not been extended on the Northern Railroad. In the first place it is applicable only to locomotives having cylinders with separate steam-chests, and the number of these on that road is very small. In the second place the advantages would be important on a line of light traffic where fuel was dear and where the work to be done, even if variable, was never very heavy; but for heavy traffic the effort must be always to obtain the greatest possible useful effect from the steam without employing any arrangements which may diminish the power of the machine.

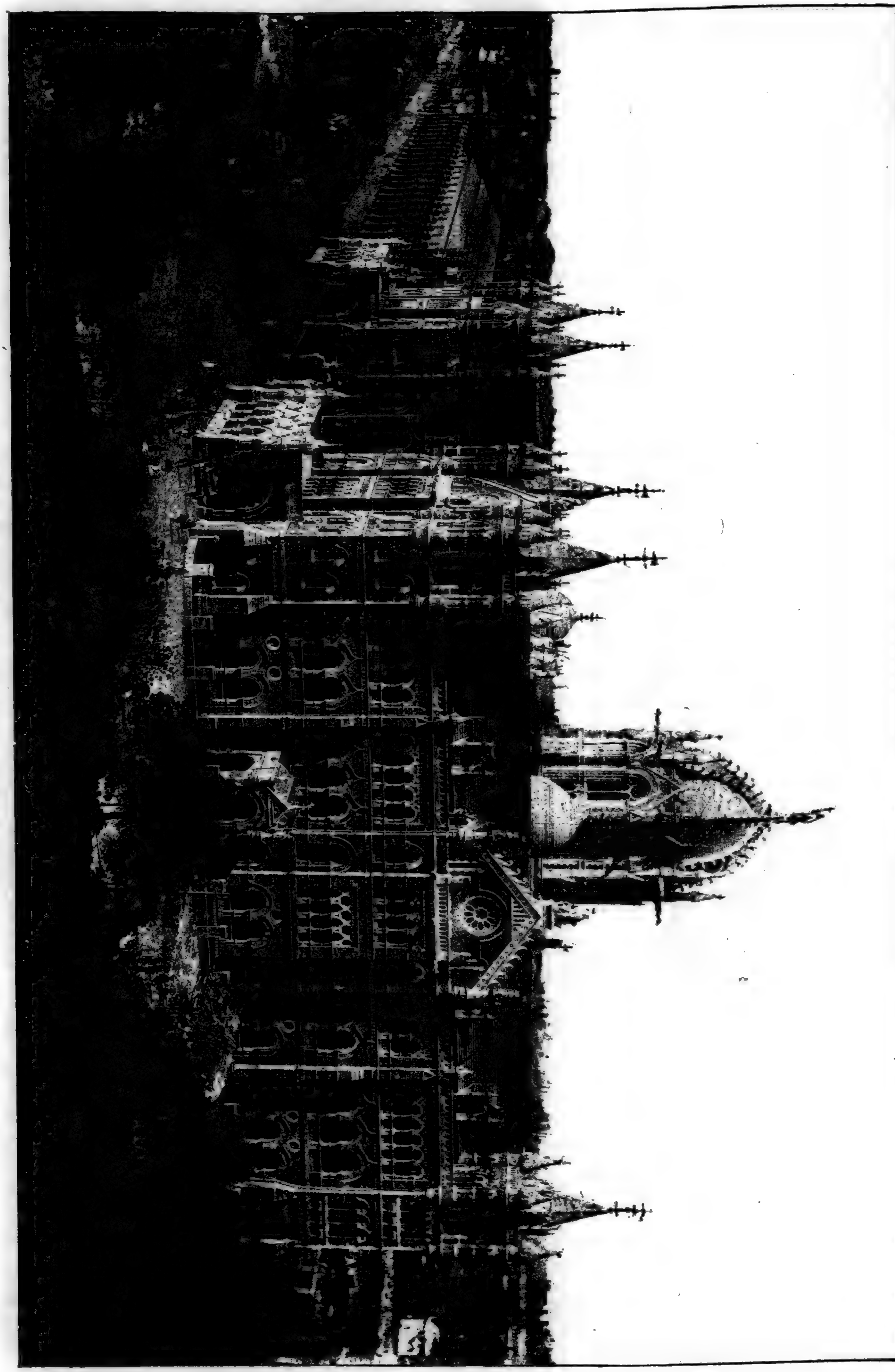
Experiments made on the State railroads of Holland with similar apparatus resulted more favorably. Two different engines were used there, one having both cylinders of the same size, as in the Northern Railroad engine, the other having low-pressure cylinders the same diameter, but double the stroke of the high-pressure cylinders. In this case the saving in fuel was from 17 to 19 per cent. in the compound engine.

THE VICTORIA STATION AT BOMBAY.

(From *Indian Engineering*.)

THE accompanying illustration shows the new Victoria Terminal Station of the Great Indian Peninsula Railway at Bombay, which is one of the finest railroad stations in the world.

It is the largest modern architectural work yet erected in India, and is believed to be the most extensive of its kind in existence. The execution of this work extended over a period of 10 years, and was completed in May last. The cost of the whole scheme amounted to about 27 lakhs of rupees ($964,000). The total length of the façade facing Hornby Row is over 1,500 ft. The author of the design is Mr. F. W. Stevens, late of the Public Works Department, who also supervised the construction of the buildings from the commencement to the end. The site on which the buildings are erected faces that on which the new Municipal Buildings are to be built, also from the designs and under the supervision of Mr. Stevens.



THE NEW VICTORIA STATION, BOMBAY, INDIA.

The style of architecture adopted for the Terminus is a free treatment of Venetian-Gothic with an Oriental feeling, which has been proved to be the best adapted for the climate of Bombay. The principal feature of the edifice is the large central masonry octagonal dome, which has a fine and dignified effect, and can be seen from all parts of the city. The dome is of solid cut stone masonry, and its construction is exposed to view both inside and outside. It crowns the grand central staircase and Hall of the Administrative Offices. The drum of the dome is pierced by eight two-light lancet windows, glazed with painted glass of ornate design, the monogram and arms of the Company being freely introduced. The apex of the dome is crowned by a colossal statue in stone of "Progress," 16 ft. 6 in. in height, which has a most imposing effect from below. The principal gables are crowned with groups of colossal sculpture representing Commerce, Engineering, Agriculture, Science and Trade, and under a canopy below the large clock (12 ft. 6 in. in diameter) in the central gable is placed a beautiful statue of H. M. the Queen-Empress, typical of the State, the railway being guaranteed by the Government. On the piers of the large entrance gates to the Administrative Offices are placed colossal figures of a lion and tiger, representing respectively the United Kingdom and India. Medallion heads in full relief of various gentlemen connected more or less with railway enterprise in India, have been placed in circular panels over the outer arches of the corridors.

The interior of the buildings has been most skillfully arranged, and fitted up in an appropriate and artistic manner. Colored polished marbles and granites have been used in the halls, waiting-rooms and refreshment rooms.

A FAST ITALIAN CRUISER.

THE Italian cruiser *Piemonte*, lately completed by Armstrong, Mitchell & Company at Elswick, England, has attracted much attention on account of the high speed which she has developed on her trial trips, and because she is the representative of a class of vessels which naval officers are regarding with increased favor as compared with the enormously heavy armored ships, of which the *Benbow*, illustrated on another page, is a striking example.

The type of war-ship of which the *Piemonte* is a noteworthy specimen is that to which the new 2,000-ton cruisers for our own navy will belong—lightly armored, of great speed, easily and quickly manœuvred, and carrying an offensive armament of considerable power, much greater, in proportion to their size, than the heavy armored ships.

In the accompanying illustrations fig. 1 is an elevation; fig. 2 a deck plan; fig. 3 a wave-line diagram; figs. 4, 5 and 6 partial cross-sections of the ship, the leading dimensions of which are as follows:

Length over all	300 ft.
Breadth " "	38 "
Draft forward	14 "
Draft aft	16 "
Maximum speed attained	21¼ knots.
Maximum power of engines, with forced draft	11,600 H.P.
Displacement (tons of 2,240 lbs.)	2,500 tons.
Division of weight:	
Hull and fittings	970 "
Armor	280 "
Equipment and stores	130 "
Boilers and machinery	720 "
Armament	200 "
Coal, normal capacity of bunkers	200 "

For cruising purposes the ship can carry three times her normal allowance of coal, or 600 tons.

The machinery and boilers are entirely below the water-line, and are protected by the armored deck, which also covers the magazines, the steam-steering apparatus, and the electric light plant.

This armored deck extends the whole length of the ship, and varies from 1 in. to 3 in. in thickness. All the hatchways, which must be left open in action, are enclosed in bulkheads rising 4 ft. above the construction water-line.

The ship is divided by bulkheads into a number of water-tight compartments. Each engine is in a separate compartment, and the boilers are also placed in a compartment. A second or lower deck, made water-tight, extends the greater part of the length of the ship, and is broken only over the boiler-room. This deck is shown in dotted lines in fig. 1.

The coal-bunkers are placed on either side of the engines and boilers, serving as further protection to those vital parts of the ship. These bunkers are between the upper deck and the armored deck, extending along the side of the ship, and are divided into rooms 10 to 12 ft. long by the cross-bulkheads. Fore and aft of the boiler-rooms and under the armored deck is a space from 2 ft. to 3 ft. high, which can also be used for the storage of coal.

The arrangement of the main bunkers is shown in cross-section in fig. 4; in this the lower part is shown occupied by briquettes of compressed fuel. This fuel is not only of higher heating power than ordinary coal, but also has the advantage that it can be packed down so tightly that water can hardly pass through it should the side be penetrated by a shot, and it also offers greater resistance to a projectile than loose coal. Coal in sacks, or briquettes, can also be packed over the armored deck to a height of 2 ft. This serves as some additional protection when, by the consumption of the coal stored below, the ship is lightened, so that the armored deck rises slightly above the water-line.

With a full allowance of coal on board, the armored deck is 6 in. below the line of normal immersion.

In relation to the armor protection of this ship, the *Mittheilungen aus dem Gebiete des Seewesens*—to which we are indebted for the illustrations—says:

"The partial sections given in figs. 5 and 6 show the side-armor which the *Piemonte* could carry instead of the armored deck, without increasing her displacement.

"Fig. 5 shows the arrangement of the armor under the condition that the weight of the coal-briquettes—100 tons—shall be dispensed with; fig. 6 the arrangement under the assumption that the ship shall carry the normal weight of coal—200 tons.

"In both cases the unbroken deck-plating along the upper side of the armored belt is of equal strength with the horizontal part of the actual armored deck of the *Piemonte*—that is, 1 in. thick. In the most favorable case, in fig. 5, the broadside resistance—counting in the teakwood backing and the side-plating—would be equal to that of a solid armor-plate 10½ in. thick.

"If in this ship the weight of the briquettes were replaced by armor, as assumed in fig. 5, the thickness of the sloping part of the armored deck could be increased to 6 in., and such a deck would be equal in protection to side-plating 14 in. thick. But it must also be considered that the layer of briquettes will oppose a very useful resistance to a projectile with a bursting charge, since such a shot would be held by it and caused to explode, so that the sloping portion of the armored deck, though only 3 in. thick, would be reached only by the fragments of an exploded shell, while the heavy side-plating would receive the full direct blow of the projectile.

"It may also be noted that the cost of the ship with the armored deck is much less than it would be with side-armor of equivalent strength."

Like all modern cruisers, the *Piemonte* has twin screws. Each screw is driven by a triple-expansion engine having a high-pressure cylinder 36 in. diameter, intermediate cylinder 55 in., and two low-pressure cylinders each 60 in. diameter; the stroke is 54 in. Steam is furnished by four cylindrical boilers, with furnaces at each end, and made to carry a working pressure of 155 lbs. Eight fans are provided for use when the boilers are run with forced draft. The engines and boilers were built by Humphreys, Tennant & Company, at Deptford, England.

A distilling apparatus and an auxiliary condenser are provided in each boiler-room for use with salt water when the ship is at sea.

An auxiliary boiler to provide steam for the pumps, electric light, etc., is placed above the armored deck.

On the trial trips the *Piemonte* attained a speed of 19.5 knots with natural draft. With forced draft, but light pressure, a speed of 20.168 knots was attained, and when the full power of the engine is developed and full pressure of forced draft on the boilers, she is expected to reach a speed of 21.5 knots.

In fig. 3 an outline of the ship is shown, and the full line *a a* shows the wave-line, which would be caused by the motion of the ship at 20 knots an hour; the dotted line between the same points is the wave-line at 21 knots.

During the trial trips the vibration of the ship at high speed was taken with a seismometer. It was very small, the variations due to her motion not exceeding 0.12 in. in either the vertical or horizontal direction.

As mentioned above, while the normal coal-supply is 200 tons, the *Piemonte* can stow on occasion 600 tons; with this provision she can run 1,950 knots at full speed with natural draft. Making from 10 to 12 knots an hour, 600 tons of coal will carry her about seven times that distance, making her cruising range at low speed about 13,500 knots, or from 50 to 55 days.

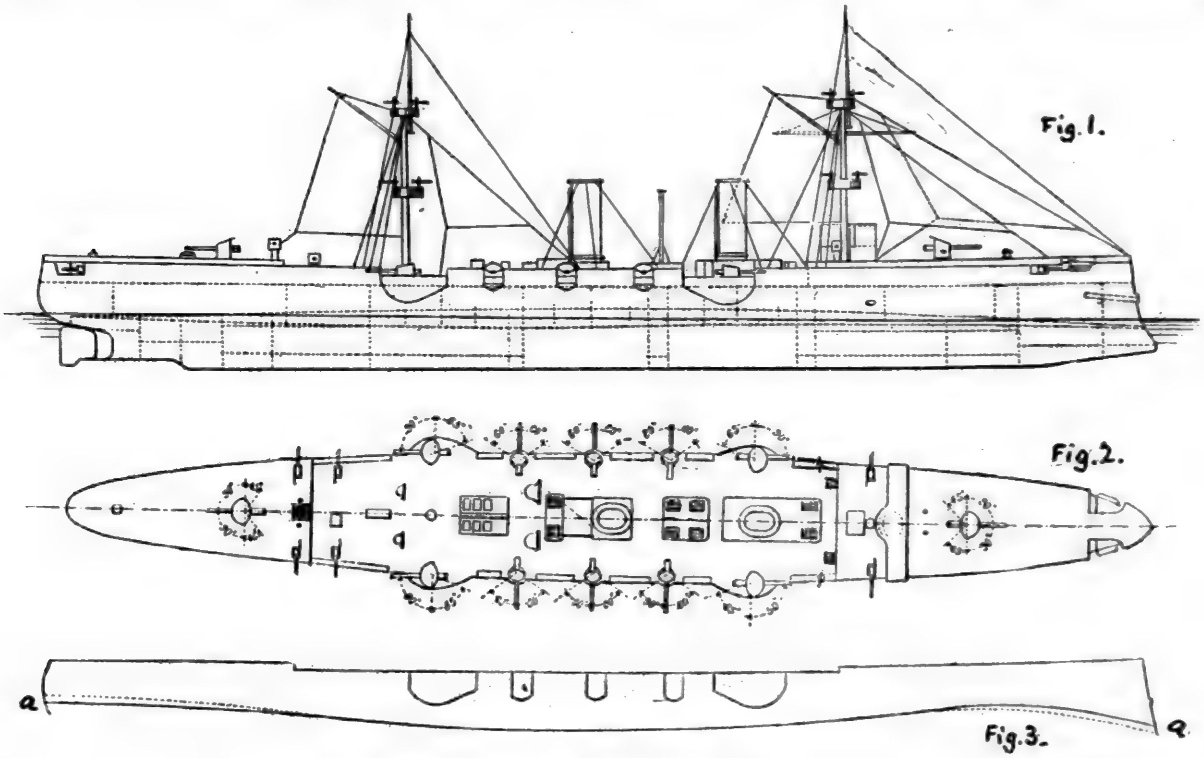
The *Piemonte* is not only a typical ship in her construction and machinery, but she has also a claim to notice from the fact that she is the first cruiser of importance armed entirely with rapid-fire guns, thus carrying out the theory that many shots from comparatively light guns may be more effective than few from very heavy guns.

The ship carries altogether six 15-cm. (5.9-in.); six 12-cm. (4.7-in.); ten 57-mm. (2.24-in.), and six 37-mm. (1.46-in.) rapid-fire guns; four 10-mm. (0.39-in.) Maxim guns and three torpedo-tubes. The arrangement of these guns, as shown on the deck plan, fig. 2, is as follows: Of the 15-cm. guns, two are mounted in pivot, forward and aft, and four in broadside on the upper deck; the six 12-cm. guns are all in broadside. Of the ten 57-mm. guns six are in broadside on the upper deck; the other four are on the lower deck, two forward and two aft. Two of the 37-mm. guns are on deck, in broadside. The two masts of the ship each carry two platforms, or fighting-tops; the two lower ones are each armed with two 37-mm. guns, the two upper ones each with two 10-mm. Maxim guns. One of the torpedo-tubes is fixed in the bow, the other two in broadside, forward of the boiler-room.

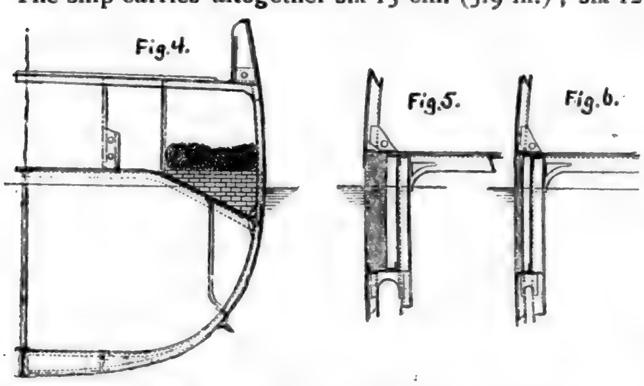
The guns on the upper deck are all provided with steel shields for the protection of the gunners; those for the 15-cm. and 12-cm. guns are 4½ in. thick, and those for the smaller guns are lighter.

The *Piemonte*, it will be seen from this description, has the qualities of a fast cruiser, able to do much damage to an enemy's commerce, and to deliver quick blows at unexpected points; she is also, from her speed, heavy armament and quickness in manœuver and in fire, a formidable fighting machine.

The same qualities, it is expected, will be combined in the new 2,000-ton and 3,000-ton cruisers of our own Navy, contracts for which will be let this month. It is to be hoped that in their construction advantage will be taken of the lessons which the *Piemonte* and her sisters will teach by their behavior in service at sea.



THE FAST ITALIAN CRUISER "PIEMONTE."



A NEW PASSENGER STATION.

Only a few years ago the stations of the railroads reaching New York by way of the west shore of the Hudson were altogether insufficient for their purpose, and, indeed, were mostly mere temporary sheds. Within a comparatively short time this has been entirely changed.

The Pennsylvania Railroad was the first company to build a passenger station worthy of the name, and has an excellent building, although the rapid growth of traffic has already reached and almost passed the accommodations it affords. The New York, Lake Erie & Western finished a new passenger station last year, and the New Jersey Central has still more recently erected a very convenient and handsome structure at its Communipaw terminus.

The latest addition to this group of stations is that of the Delaware, Lackawanna & Western at Hoboken, which was opened to the public in July.

The new station is a handsome structure of white pine, finished inside with antique oak. It is 121 × 170 ft. in size, the main waiting-room being 45 ft. clear in height in the center, and measuring 121 × 85 ft. in area. The building runs north and south, with a tower on the northwest or front corner. The eastern half of the station

stands over the river, a bulkhead running clear through it from north to south. The western half is on made ground, as well as a great part of the yard which the trains start from. The main waiting-room contains the ticket-offices, telegraph-office, information-bureau, news-stand, restaurant, etc. There are large separate waiting and toilet-rooms for men and women, a smoking-room, and all the modern conveniences. The waiting-room for passengers arriving on the trains and going to New York is large, well lighted and ventilated. It is 45 × 120 ft. in area and 45 ft. high. The western half of the building is two stories high. The second story contains a conductors' room, and the rest of that floor will be used by the Railroad Branch of the Young Men's Christian Association. The rooms are handsomely fitted up, and contain kitchen, bath-rooms, etc., for the convenience of the members. The entire building will be heated by steam and lighted both by gas and incandescent electric lights. All the windows are of stained glass, and particular attention has been paid to the ventilating of all the rooms. In connection with the new station an immense covered shed for the trains is being built, measuring 190 × 500 ft All trains will, therefore, arrive and depart under cover.

The work of tearing down the old station and dredging, filling, etc., in readiness for the new one, was begun in June, 1888, since which time work has been actively prosecuted under the direction of S. Griffith, the builder. The architect of the new building is L. C. Holden. The actual cost of building the new station has been about $25,000, but that represents only a small proportion of the entire improvement, the cost of building the bulkhead and filling in four or five acres being much more It is estimated that the total cost of the improvement is in the neighborhood of $250,000.

THE USE OF THE TRUCK ON ENGLISH LOCOMOTIVES.

(From the *Portefeuille Economique des Machines.*)

It has seemed to us, in considering the English locomotive, that it would be very interesting to show how much the use of the truck has increased in England, both for express locomotives and for smaller engines, especially tank engines used in local traffic. With this object we show in the accompanying illustrations a number of diagrams on a small scale representing in outline the types of locomotives recently adopted on most of the principal English railroads; at the same time comparing them with the types formerly in service. In each of these diagrams the date placed above the engine shows the year of the adoption of that special type.

Nos. 1-4 show the engines of the Midland Railway; No. 1 being the type of 1860, with its single drivers, leading and trailing wheels; No. 2 the type of 1875 with the coupled drivers and leading wheel. In 1878, No. 3, the leading wheel was replaced by a truck, the coupled drivers being retained, but in the latest type—that of 1887, No. 4—a single pair of very large drivers is substituted for the coupled wheels, a pair of trailing wheels being placed behind the fire-box and the truck in front being still retained.

On the Great Eastern—Nos. 5-8—the development proceeded, as will be seen, on very similar lines, the only difference being that on this road the coupled drivers with truck succeeded the single drivers and trailing wheels, which appear in the type of 1880.

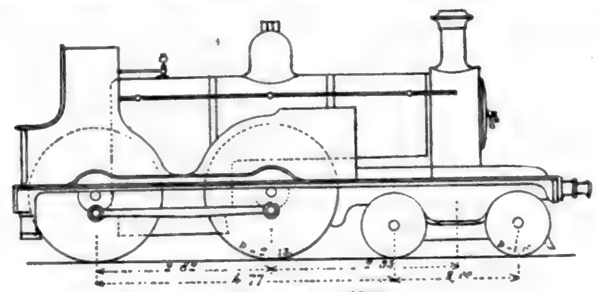
On the Great Northern the type of 1858 and that of 1870 differ only in the substitution of the truck for the leading wheels, as shown in Nos. 9 and 10. On the Caledonian—Nos. 11 and 12—the types of 1862 and 1886 are substantially the same as on the Great Northern, here also the truck being substituted for the single pair of leading wheels.

On the London & Southwestern two classes of engines are shown, the fast passenger engine of 1860, No. 13, being succeeded by the type of 1883, No. 16, the change, as in all the previous instances, being made by the substitution of the truck for the leading wheels. Nos. 14 and 15 show the local passenger engine of this road; here again the truck at the forward end has supplanted the single pair of wheels.

The Southeastern types show an engine of the Forney pattern with tank and coal-box carried on an extension of the frame, the coupled driving-wheels being placed under the boiler, with the truck under the tank. This is the type of 1878, No. 18, which succeeded No. 17, the type of 1860, in which there was the same arrangement of relative position of boiler and tank, but with a single pair of wheels under the tank in place of the truck.

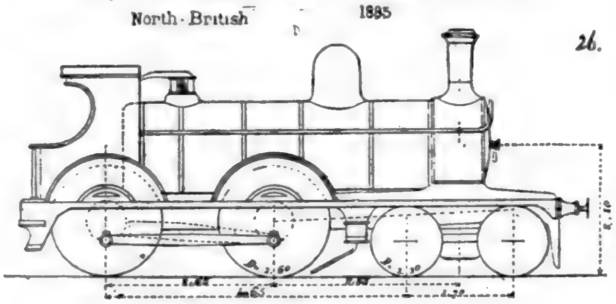
Nos. 19 and 20, the Northeastern types of 1874 and 1887; Nos. 21 and 22, the Manchester, Sheffield & Lincolnshire engines of 1865 and 1879; and Nos. 23 and 24, the Glasgow & Southeastern types of 1873 and 1883, all show substantially the same arrangement, the coupled drivers at the rear of the engine, with the leading wheels in front; in each case the leading wheels have been replaced by a truck in the later types.

No. 25, the North British express engine of 1885; No. 26, the Lancashire & Yorkshire type of 1886; and No. 27, the Great Southern & Western, of Ireland, pattern of 1884, all show engines with coupled drivers and forward truck. In each of these cases this type of engine with truck replaced earlier patterns with a single pair of leading wheels.



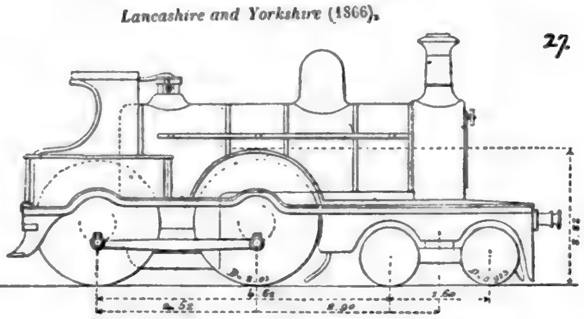
North-British 1885

26.



Lancashire and Yorkshire (1866).

27.



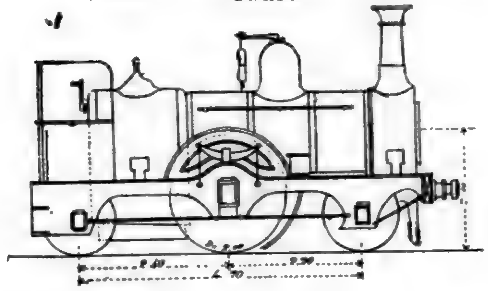
Great Southern and Western (1884).

These diagrams show in a very strikng way how generally English engineers have abandoned the rigid wheel base, and to what extent they have adopted for passenger service the American type of engine in its general outlines. The truck is now in use in the standard passenger engines of all except two or three of the principal English roads. It has been adopted in that country to a very much greater extent than on the railroads of France and Germany, where as yet the American type is very little known.

It must be remarked that this adoption of the truck in England has not resulted from any expectation of increase of power of the engine, which, of course, could not be secured in this way, nor has it been done to save the road-bed, for, as is well known, the English lines are of extreme solidity. The object has evidently been to increase the stability of the engine, especially at the very high speeds at which trains are now run in that country.

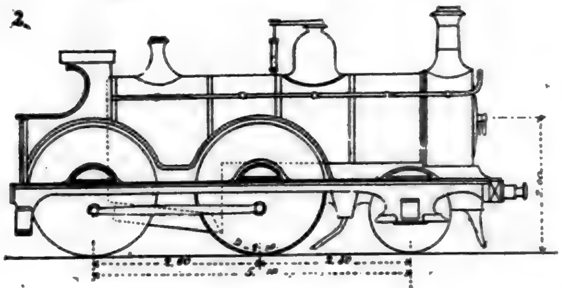
1860. Midland

1

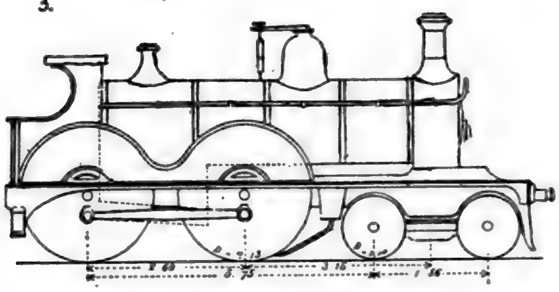


1875.

2.

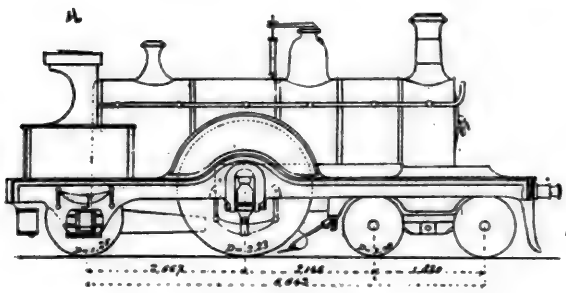


3. 1878.



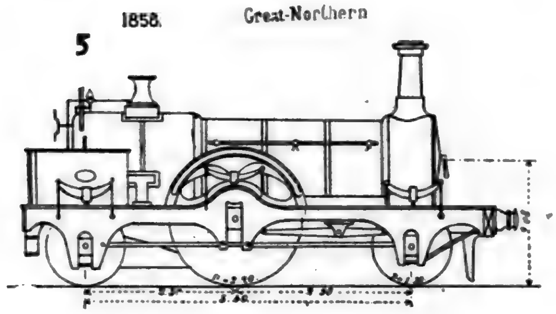
1887.

4.

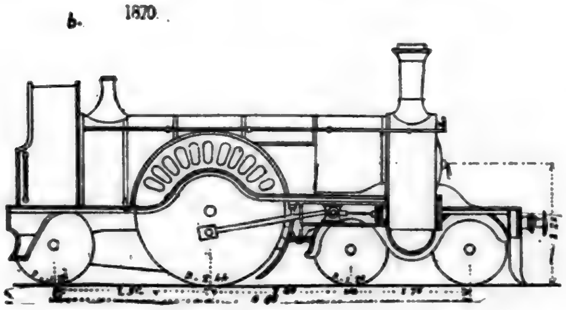


1858. Great-Northern

5

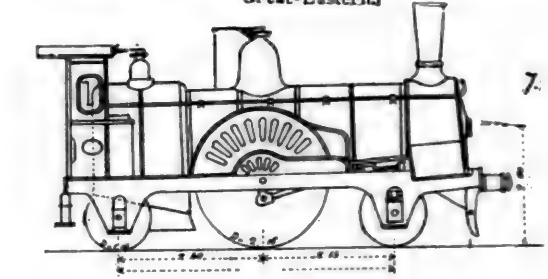


6. 1870.



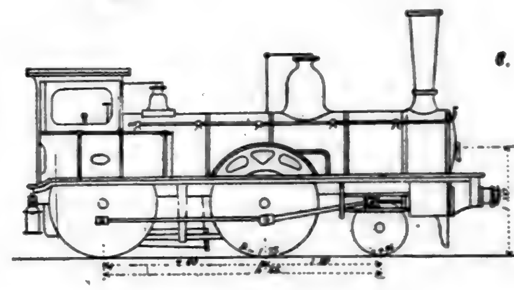
1863 Great-Eastern

7.



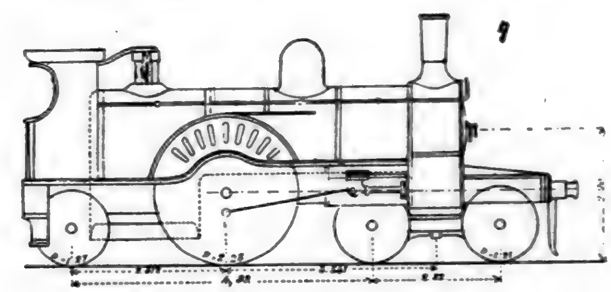
1863.

8.



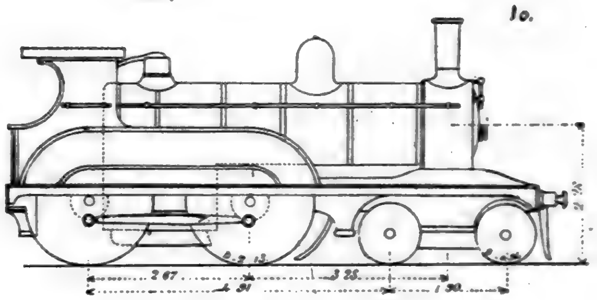
1880.

9



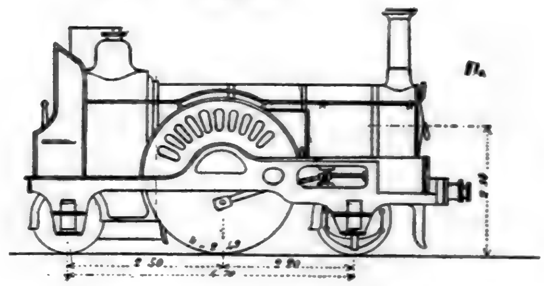
1885.

10.



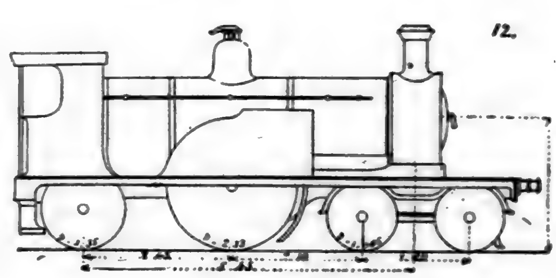
1862. Caledonian

11.



1886

12.



HYDROGRAPHY AND HYDROGRAPHIC SURVEYS.

By Lieutenant Henry H. Barroll, U.S.N.

I.—GENERAL DEFINITIONS.

Hydrography, which is, as its name implies, a description of the waters of the globe, appears to have had its beginning in the very earliest times, although the lack of instruments and of accurate measures of time and distance prevented any full development of the science. We know that the earliest navigators brought back from their voyages rough maps, charts, sailing directions and daily records, or, as they would now be called, log-books. The mariner is so dependent upon the elements that he naturally becomes a close observer, and the earliest sailors of whom we have any distinct record were in the habit of carefully watching and noting Hydrographical and Meteorological facts.

With the invention of the mariner's compass and the quadrant, the first distinct advance in the science was made, and a far greater step was taken when the chronometer and barometer were added to the instruments at the command of the sea-captain. At a comparatively early date the maritime nations of Europe established official bureaus for the purpose of collecting hydrographic information; the Portuguese were the first, and were followed at various intervals by the Spaniards, the English, and the Dutch.

The first Hydrographic Bureau in the United States was established in 1830, when a branch of the Navy Department was devoted exclusively to furthering the interests of navigation by the collection and dissemination of hydrographic information. The first charts of this bureau were published in 1835 under charge of Lieutenant Wilkes, and subsequently, under Lieutenant Maury, very notable work was done, especially in the definite determination and mapping out the limits of the Gulf Stream and other great ocean currents. Lieutenant Maury, in fact, formulated and arranged our previous knowledge on the subject and added very largely to it, and his system, somewhat amplified, and added to, has continued in use until the present day.

II.—HYDROGRAPHIC SURVEYS.

The earlier charts were necessarily of a very rough character, and more resembled what would be now called running surveys. With the improvement in instruments and methods the present degree of excellence in map and chart-making has been reached, and not only have the waters and the shores of civilized countries been accurately plotted, but the leading maritime nations have joined in surveying the shores of uncivilized and semi-civilized countries such as Africa, the Pacific Islands, China, etc.

It must not be supposed, however, that a hydrographic survey once made is made for all time; a continual change of shore-lines and channels is going on, due to the constant action of the sea, causing abrasion in some places and filling up in others; to shoals formed by wrecks, and other causes.

There are several systems, or classes, of hydrographic surveying, differing from each other by the degree of exactness to which each system will attain, and the system employed in any given case would depend upon the degree of exactness required.

They are all, however, based upon one common principle: that of establishing one position, and then, at regular intervals of time, taking soundings in a given direction, and establishing another position, and thereafter assuming that the soundings taken at regular time intervals were at regular distances along the line joining these two positions.

The simplest form of a hydrographic survey is that known as a "Running Survey." Such a survey is not of much value except as a recognizance, and is not generally resorted to except in cases where, owing to the hostilities of savages or some other cause, it is impracticable to land.

A running survey is made by a vessel zigzagging, tacking or traversing along the coast, fixing her position as best she can from her known latitude and longitude at each time of tacking, and taking soundings at regular intervals of time between these points, and keeping as uniform a rate of speed as possible.

In this way, however, a number of V's or angles would be formed, within which dangerous rocks or shoals might exist, which would escape the notice of the surveyor. For greater exactness, then, other traverses, crossing these first at some comparatively large angle, would give double the amount of assurance that no such danger existed.

Where these traverses crossed each other the nearest soundings (reduced to a mean stage of the tide) should agree, or be approximately the same, and would thus act as a check upon the work. In this way each succeeding series of traverses would add to the accuracy of the work, provided always that the directions of the lines of traverse did not cross each other at very acute angles.

A careful and detailed survey of a coast or harbor would comprehend the having of at least three series of parallel lines of soundings crossing each other—for example, one series running North and South, a second series running East and West, and a third running Northeast and Southwest. By drawing four or five parallels in each of these directions it will be readily seen how much more accuracy would be attained than by a single series of traverses, as described under the title of a Running Survey.

In shallow water it is necessary to take much more frequent soundings than in deeper water, since where there is a considerable depth a contour of the bottom is not of so much importance. Where there is less than six fathoms, for instance, the hydrographer would probably require three times as many soundings in the same distance as in deeper water. The position of these soundings is fixed from time to time, as well as at the beginning and end of each line of soundings, by comparison with objects along the shore, which have been previously located. In shallow water soundings are generally taken from boats; in deeper water from the deck of a vessel. In making ocean surveys out of sight of land the position of the vessel at the time of the taking of each sounding is determined by regular astronomical observations.

All different sounding lines are plotted from day to day upon chart paper, and the lines are carefully checked in order to avoid mistakes. In all soundings it is necessary to note not only the depth, but also the nature of the bottom as indicated by the lead. In making the chart, a work which corresponds in some degree to the plotting from the engineer's note-book in a land survey, all the information that can possibly be conveyed without rendering it too close and confused is entered on the spot. This information consists of hills, towns, capes, bays, etc., rise and fall of the tide, magnitude, variation of compass, position and character of light-houses, beacons and buoys, sailing lines, etc.

The primary work of a detailed survey of a coast or harbor (where the latitude and longitude are supposed to be known) consists in first making a triangulated survey of the coast line, starting from a measured base, and establishing, by "cutting-in" lines, the positions of prominent trees, steeples and other objects of that nature, or those topographic features, such as headlands, mountain peaks, etc.

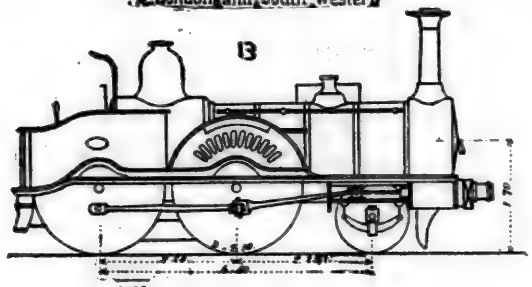
Topography on hydrographic charts is generally limited to as little as possible, that part only being topographed which will aid the navigator in "picking up the land," or in "picking out the anchorage."

This triangulated shore-line is traced upon chart paper, and we can then proceed with the hydrography of the harbor.

Should there be a rise and fall of the tide, then a tide gauge must be established, marked in feet and tenths, and an observer stationed to note and record the height of the water upon this gauge at different hours of the day, while the sounding parties are at work. The heights thus obtained enable us to reduce all soundings, taken at various stages of the tide, to some mean point or common plane. The soundings on hydrographic charts are always given, reduced to what they would have been had they all been taken at "mean low water," which signifies the *mean height of all ordinary spring low tides.*

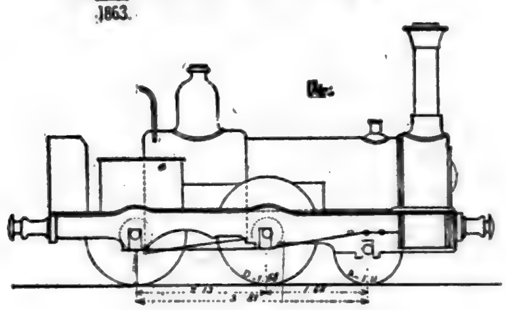
1860. London and South Western

13



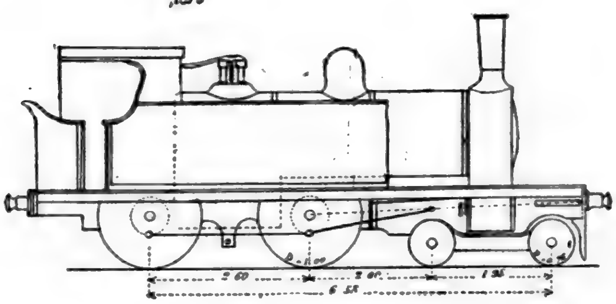
1863.

14



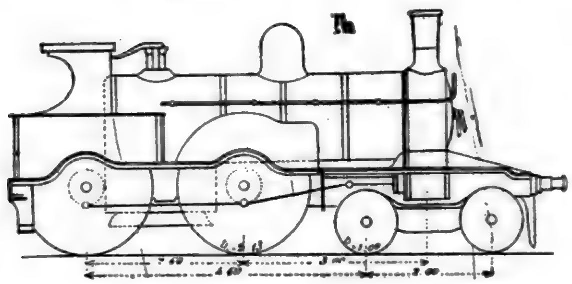
1879

15



1883.

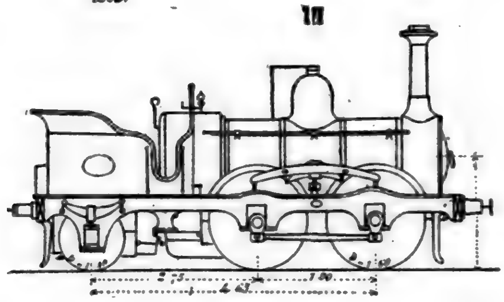
16



South-Eastern

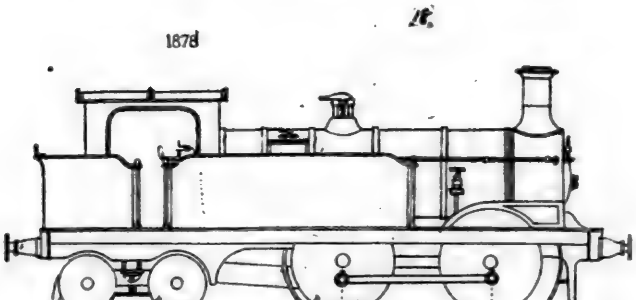
1860.

17



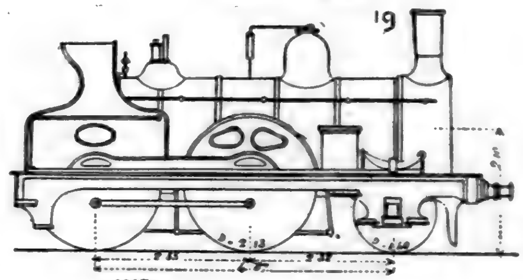
1878

18



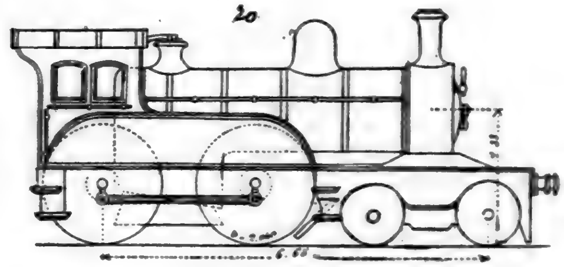
1874. North-Eastern.

19



1887.

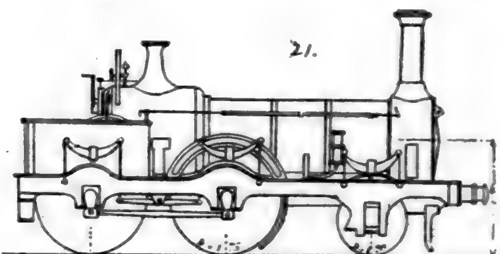
20



Manchester, Sheffield and Lincolnshire.

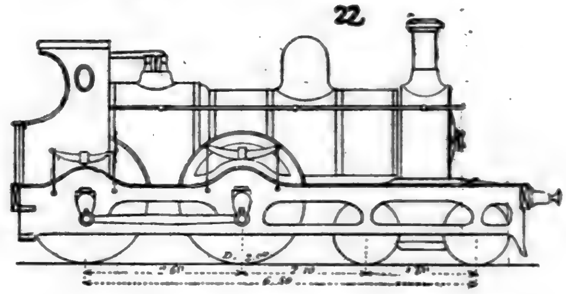
1865.

21.



1879.

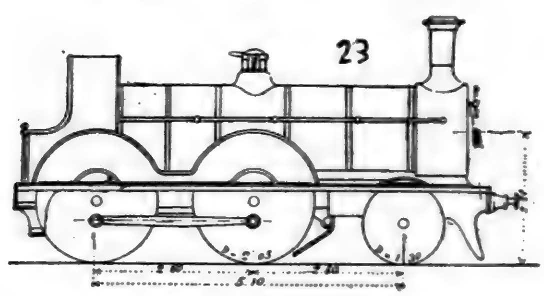
22



Glasgow and South-Western.

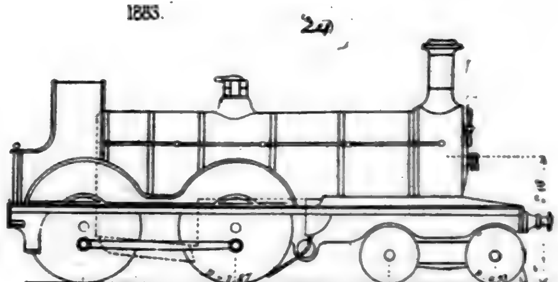
1879.

23



1883.

24



When the chart as plotted on board is complete, it is sent to the Hydrographic Office at Washington, where it is reduced to the required scale and prepared for the engraver or lithographer.

III.—LIGHT-HOUSES, BUOYS AND SIGNALS.

An important part of the work of the Hydrographic Office is to inform mariners, as soon as possible, of any change in location, or accident to any of the various light-houses, beacons, buoys and other warnings to navigators. At present there is a wide difference in the signals and lights used by different nations, but it is hoped that at the National Maritime Conference, which is to be held this fall, a uniform system of buoyage, lights, and sailing directions may be adopted. The present American system of establishing buoys in a harbor to indicate the channel to navigators is as follows:

In *entering* a harbor or *ascending* a river, those buoys which are painted wholly red, mark the right edge of the channel, and must always be left on the right-hand side. They are numbered, commencing from the sea, and the red buoys have *even* numbers. Those painted wholly black must be left on the left hand, and are given *odd* numbers.

The buoys which have black and red, *horizontal* stripes, mark some rock, shoal or wrecked vessel lying in mid-channel, and must be avoided, but may be passed on either side.

Buoys with white and black *perpendicular* stripes are called "channel" or "fairway" buoys, and denote that there is plenty of water where they are anchored.

IV.—SAILING DIRECTIONS.

All information which will aid in the navigation of the seas, and which cannot be graphically shown upon a chart, is printed in book form, and these books are known as Sailing Directions or Directories.

Such books are published by all civilized nations, describing the general appearance of the land when first seen from seaward, the direction in which the local currents or tides will drift a vessel, and giving full directions for entering the various ports.

Some idea of the magnitude of the subject may be obtained, when it is said that the sailing directions for the coast from Boston to New York require a book almost as large as Webster's Unabridged Dictionary. To carry such books for the coasts of the entire world, or for any considerable part of it, would be manifestly impossible, both on account of the expense and of the room which they would take, and mariners are limited to such information as they may absolutely require for the voyage which they expect to make. In order to assist them as much as possible the United States Government has established branch hydrographic offices in all large seaboard cities, where any one desiring such information may readily obtain the same.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE engines and boilers of the gunboats *Bennington* and *Concord* are completed, and are nearly all in position on board the vessels. The launch of both these ships may be expected some time in August. They will probably go to New York for completion, and both will be ready for their trial trips before the close of the year.

The Quintard Iron Works of New York, Contractors for the engines of the large armored cruiser *Maine*, are preparing for active work. The Standard Steel Casting Company, at Thurlow, Pa., will furnish the bed-plates, columns and other steel castings. The Bethlehem Iron Company will furnish the shafting and heavy steel forgings. The cylinders will be made by the Southwark Foundry & Machine Company, in Philadelphia, and the condensers by the South Brooklyn Steam Engine Works. The steel boiler plates will be made by the Linden Steel Company, in Pittsburgh; the tubes by the Tyler Steel Tube Company, of Boston, and the corrugated fire-boxes by the Continental Iron Works, in Brooklyn. The work on these engines will be thus pretty well distributed. They will be the largest engines of the kind ever made in this country.

There are two triple-expansion engines, one for each screw, each having cylinders 35½ in., 57 in., and 88 in. in diameter, with stroke of 36 in. Steam will be furnished by eight cylindrical return tubular boilers 14 ft., 8 in. in diameter and 10 ft. long, each having three corrugated furnaces.

The engines of the *Maine*, however, will be pretty well matched by those of the *Texas*, the large battle-ship which is to be built at the Norfolk Navy Yard. The contract for these engines is held by the Richmond Locomotive & Machine Works, at Richmond, Va., and preparations are being made there also to begin work. The engines of the *Texas* are of the triple-expansion pattern, and will have cylinders of 36 in., 51 in., and 78 in. in diameter and 39 in. stroke.

The final trial trips of the gunboat *Yorktown* and of the small gunboat *Petrel* were to take place during the last week of July. Both vessels have done so well on their preliminary trials that there is very little doubt that they will fulfil the expectations of their builders and the requirements of the Naval Department.

THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C. E.

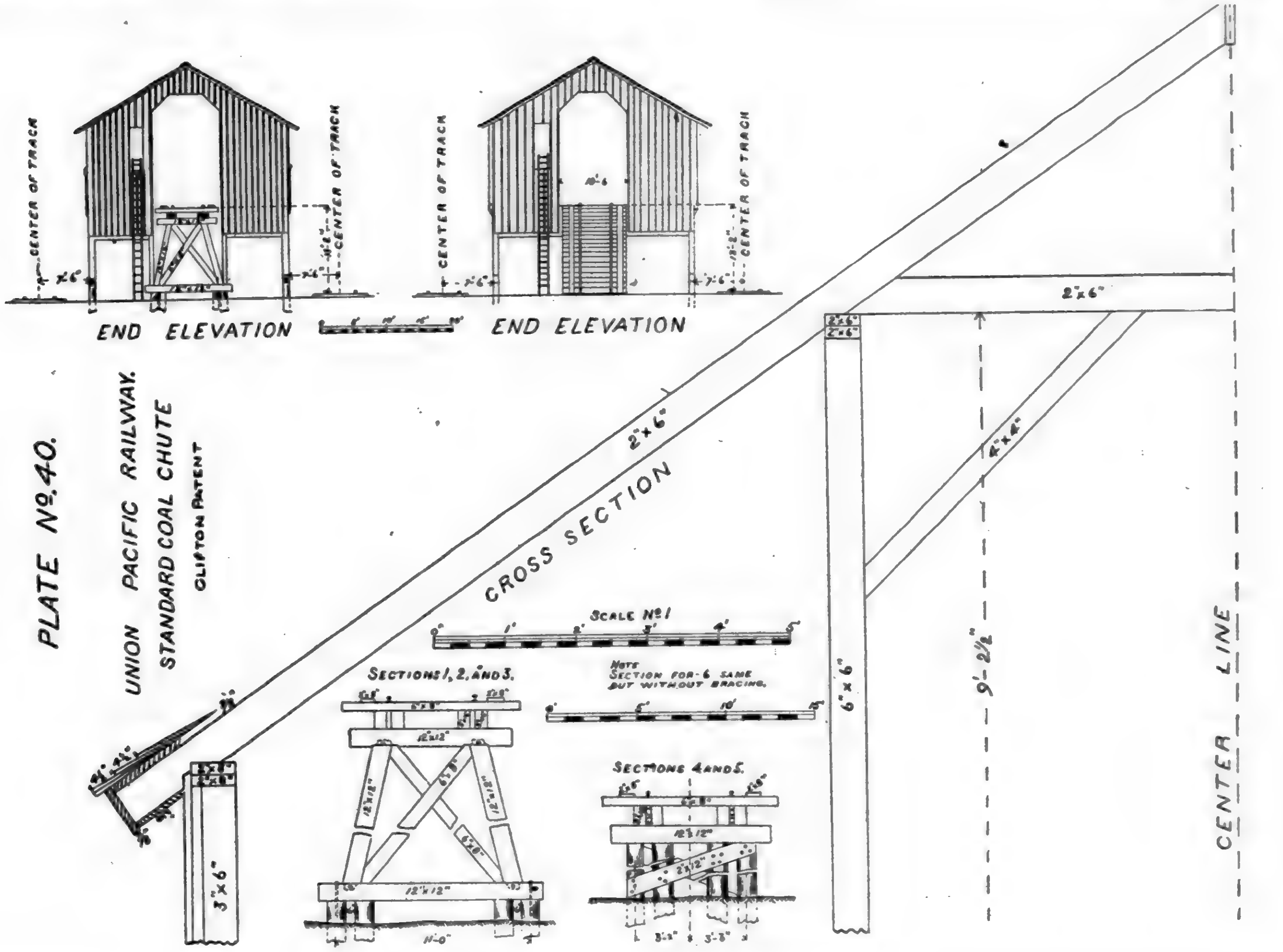
(*Continued from page* 311.)

CHAPTER XII.

COAL-CHUTES.

MUCH attention has always been paid by railroad companies to the subject of loading coal upon the tenders of their locomotives, the object being to have this coal placed upon the tender with as little loss of time and expense as possible, and also by some method by means of which an accurate account can be kept of the amount of coal consumed by each locomotive. We here present plans and details showing the construction of what is known as the CLIFTON COAL-CHUTE as used upon the Union Pacific Railroad.

Next month these plans will be followed by plans of all the iron work necessary, and at that time will also be given bills of material for the construction of coal-chutes of varying capacities. This form of coal-chute is given not necessarily because it is the best, although from what the Author has been able to gather in regard to this point, it is the one most universally used upon all our standard railroads, and one that possibly possesses less disadvantages than any other. It has been selected here more particularly owing to the fact that it comes more properly under the head of wooden structures than some other methods of loading coal that are used. One great difficulty with these coal-chutes is, that thus far no practical means has been found by which the coal can be accurately weighed, and thus the actual amount of coal used by the locomotive ascertained. As will be seen from the drawings, the pockets are made to contain approximately so much coal, and a certain number of tons is put into each pocket; then as this coal has been weighed before it was unloaded, the actual amount taken by the locomotive is ascertained when full pockets are taken; but it is usually the case that only some part of the coal in some one pocket is taken, and then it is merely guesswork as to the amount that is actually gone; and although in the end the total amount of coal used is actually known with all possible accuracy, still the amount of coal that is consumed by each locomotive can only be approximately estimated. There have been various devices by means of which these coal-chutes rest upon levers connected with the balance, the whole object being to record the difference in weight, or the weight before and after any coal had been taken out. All of these devices, however, have been exceedingly expensive, more or less


END ELEVATION
END ELEVATION
CENTER OF TRACK
CROSS SECTION
SCALE No. 1
SECTIONS 1, 2, AND 3.
SECTIONS 4 AND 5.
CENTER LINE
PLATE No. 40.
UNION PACIFIC RAILWAY.
STANDARD COAL CHUTE
CLIFTON PATENT

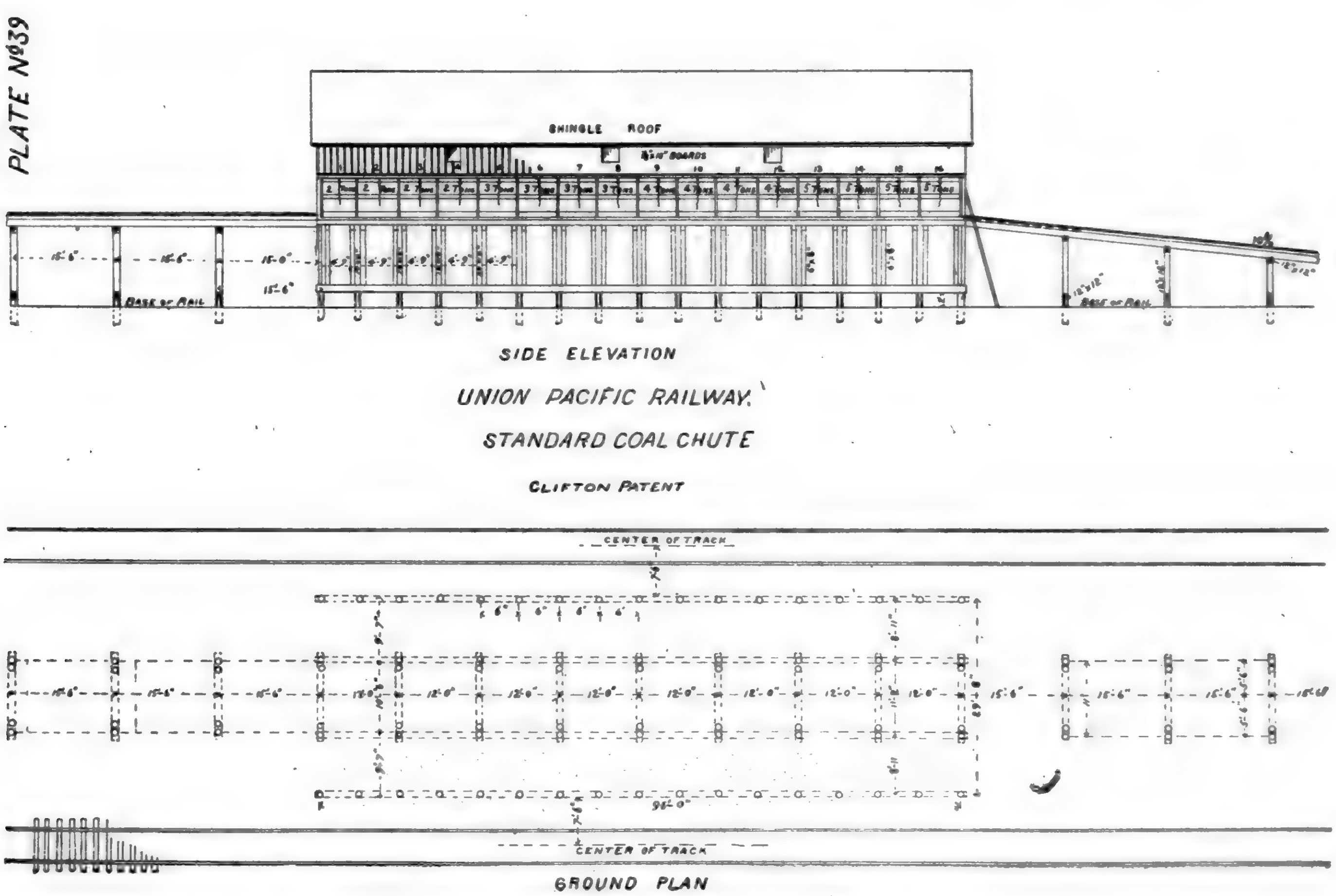


PLATE No 39
SHINGLE ROOF
SIDE ELEVATION
UNION PACIFIC RAILWAY.
STANDARD COAL CHUTE
CLIFTON PATENT
CENTER OF TRACK
CENTER OF TRACK
GROUND PLAN

PLATE No 42.

UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT

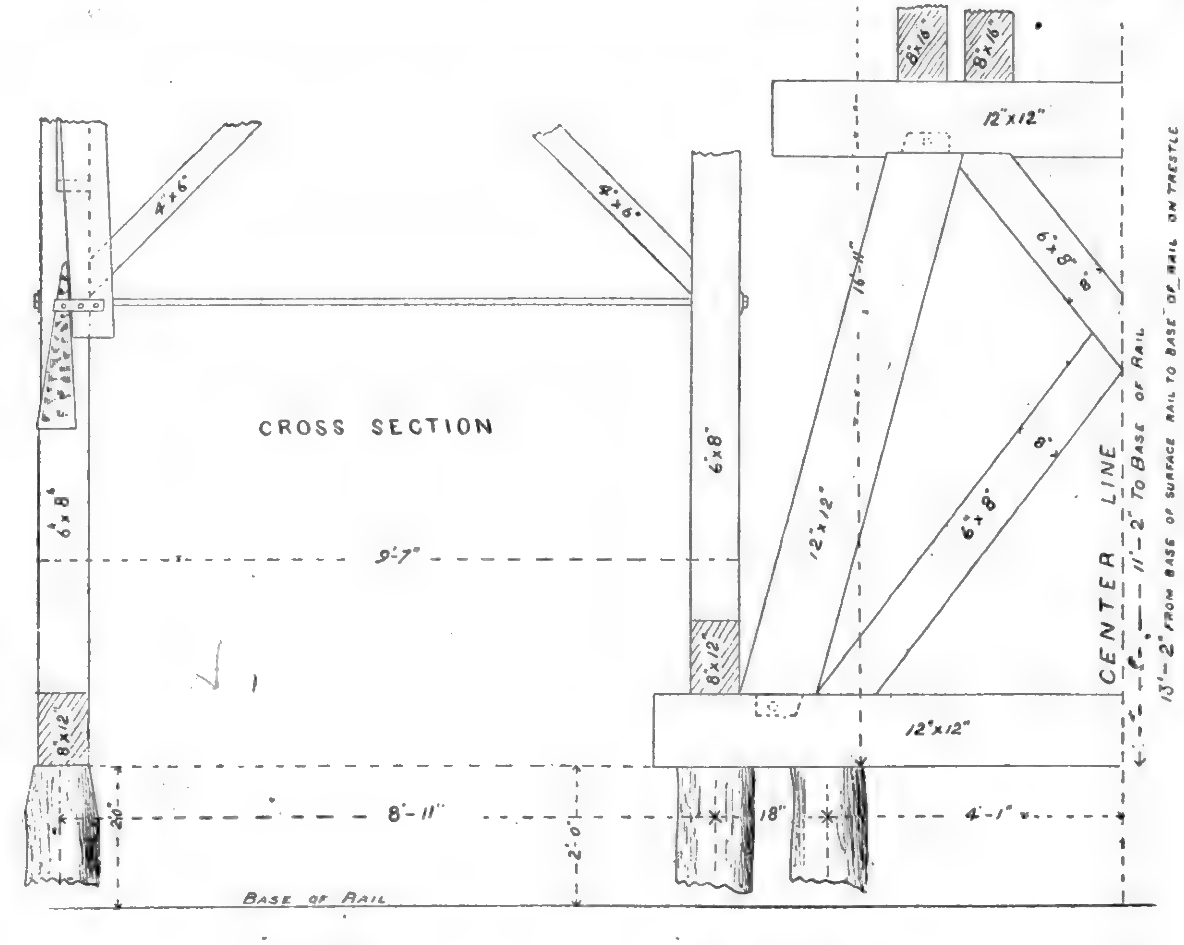


PLATE No. 41.

UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT

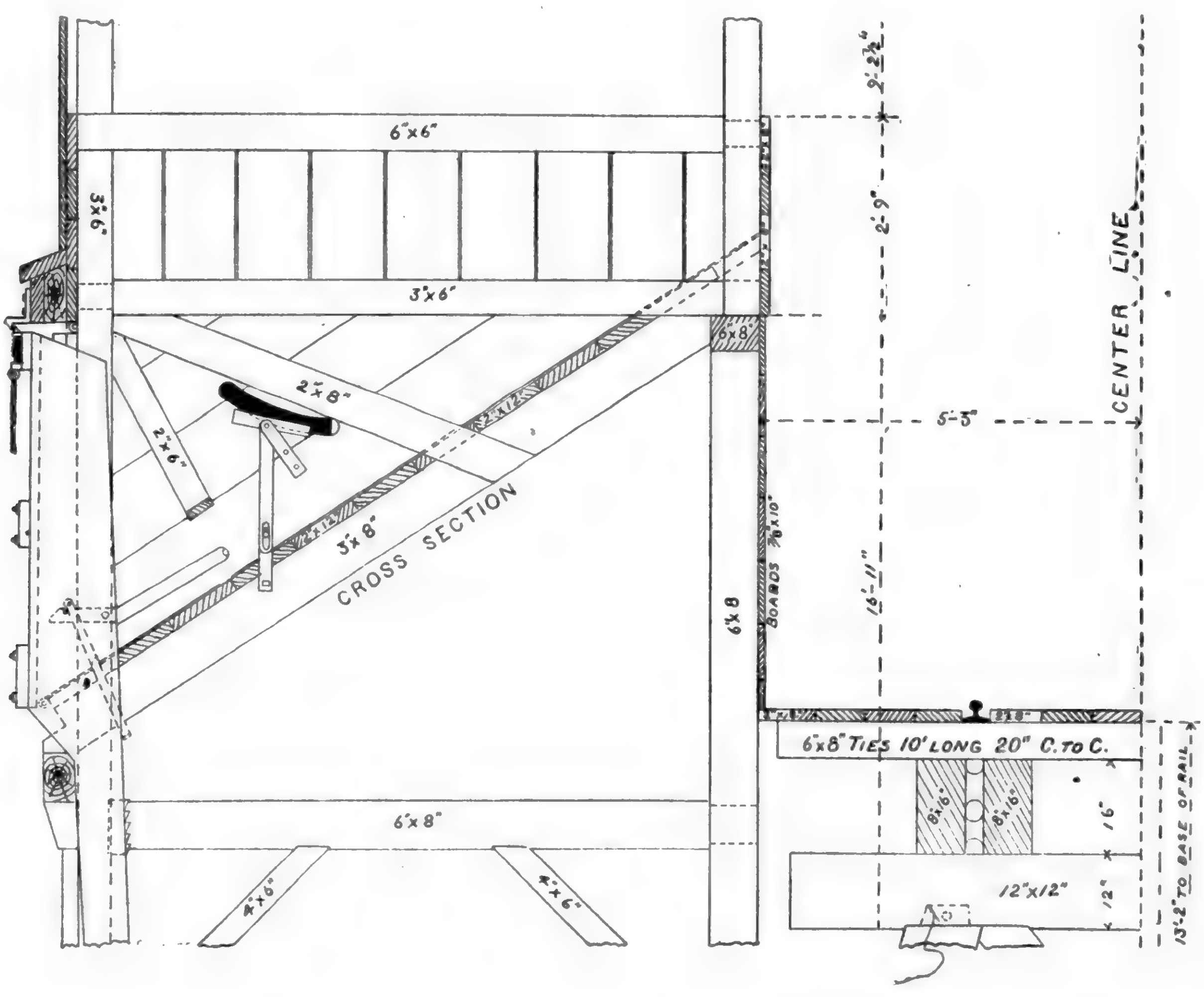


PLATE No. 44.

UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT

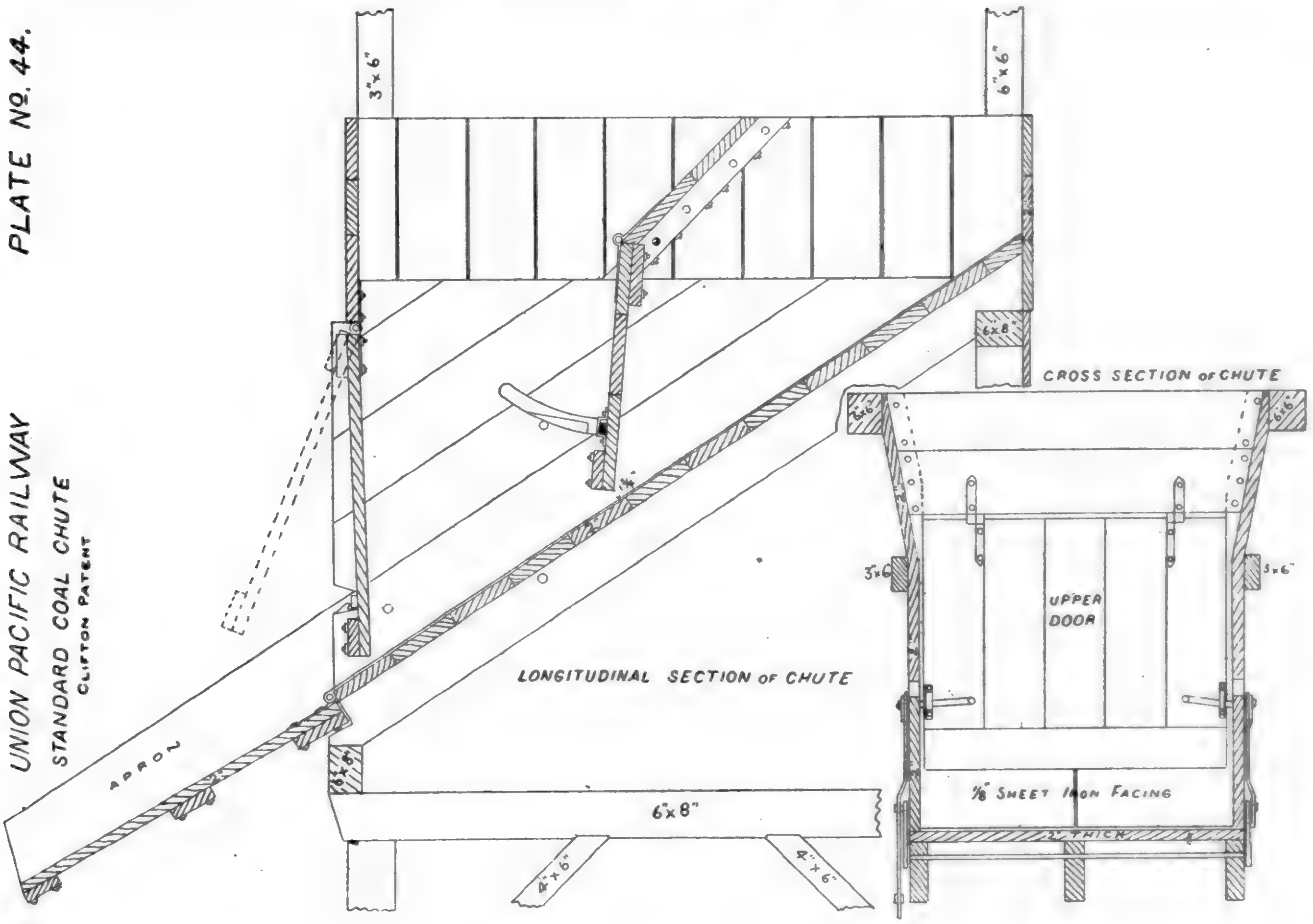
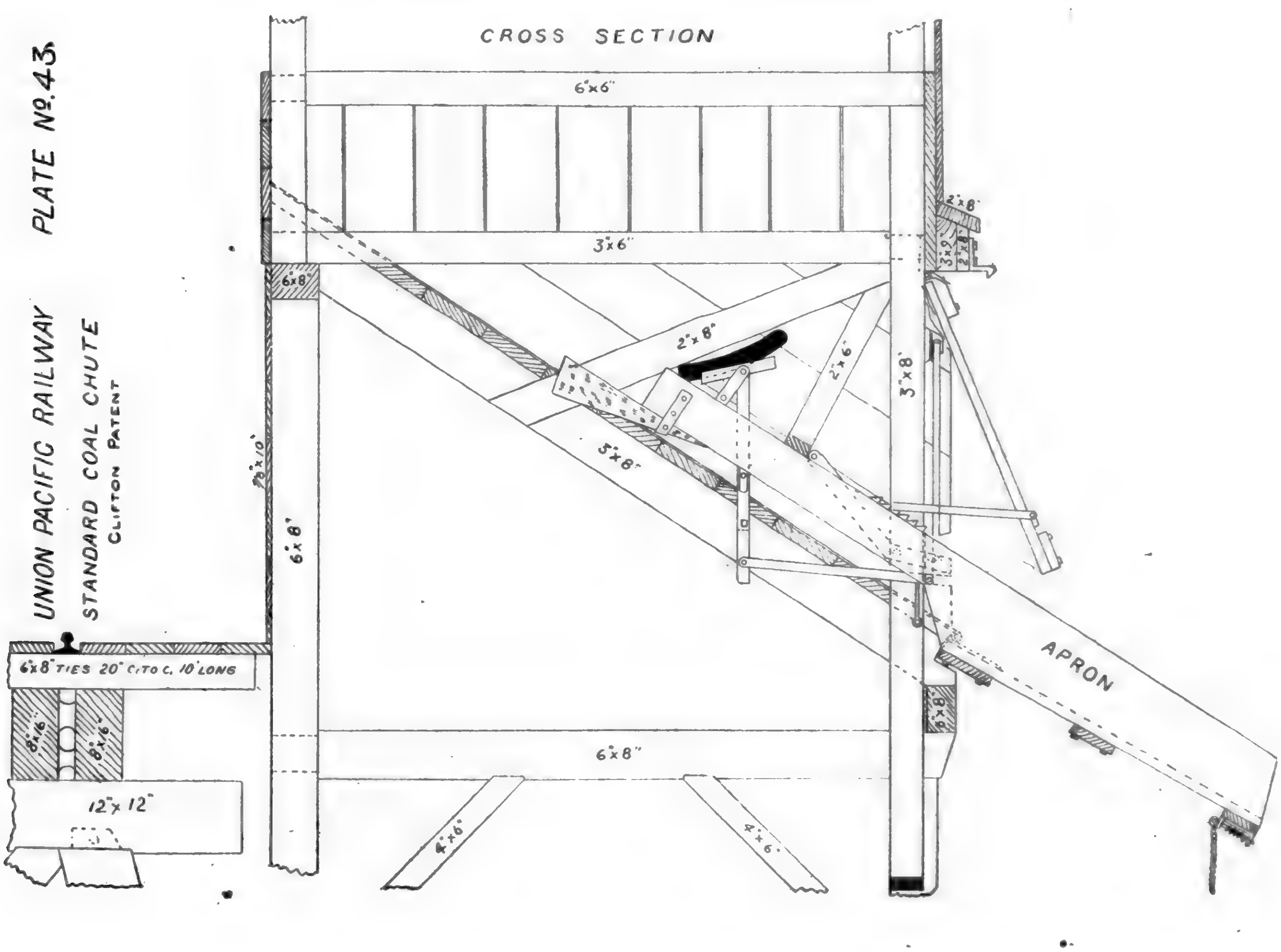
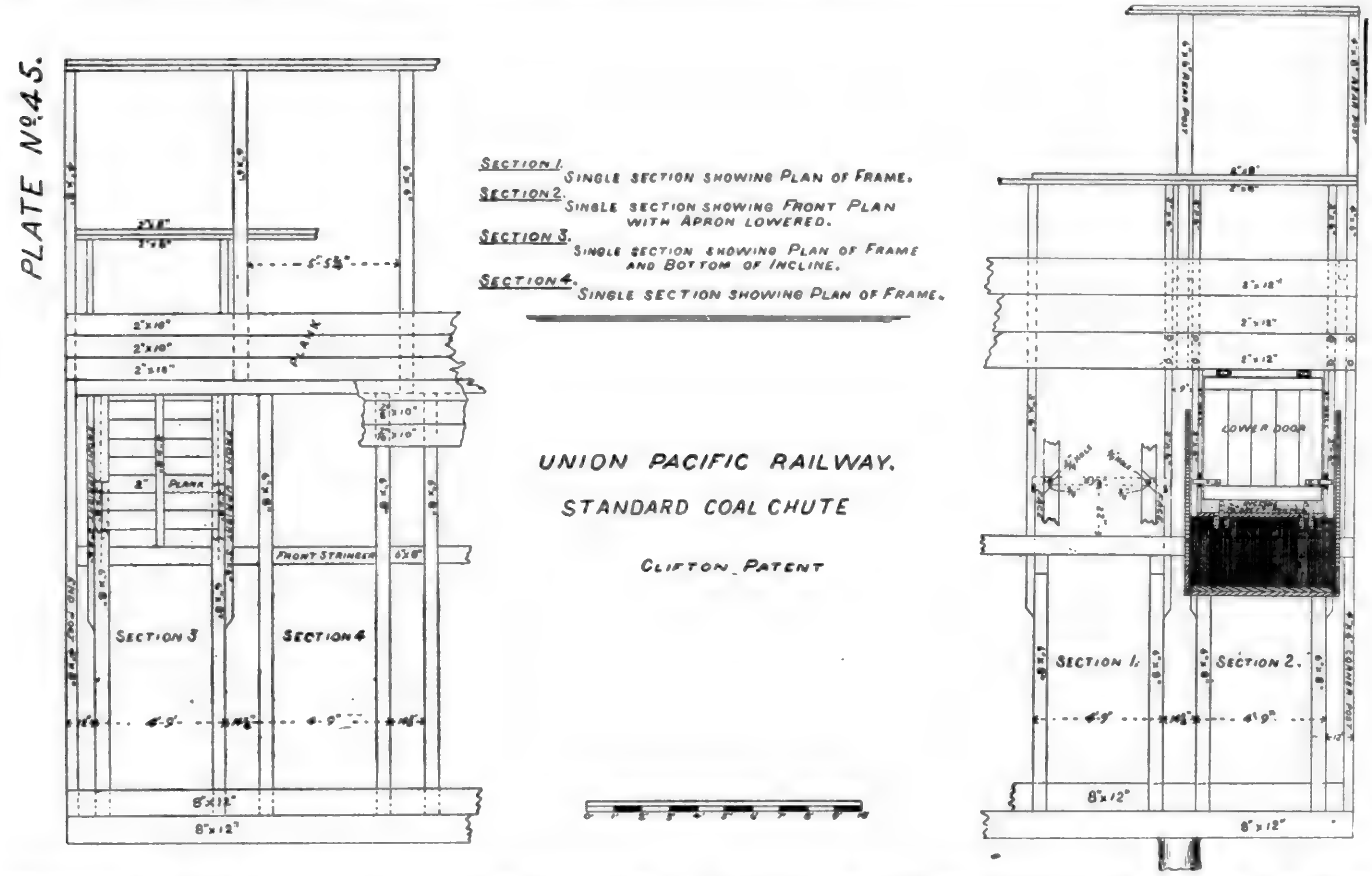


PLATE No. 43

UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT





complicated, and in no case have they given entire satisfaction. On many roads it is the practice to load the coal into small iron buckets resting upon the ground, the amount of coal in each bucket being weighed, then by means of a traveling crane these buckets are picked up and the coal dumped into the tenders when necessary. Owing to the comparatively small size of the buckets, it is very easy to ascertain the exact amount of coal taken by each locomotive, but although this method determines accurately the weight of coal used in each case, still this method of coaling the tender is an expensive one, and has some disadvantages which would always prevent it from going into general use.

There is also a coal-chute patented and manufactured by William, White & Company, of Moline, Ill., which, as far as the wooden structure is concerned, is like the Clifton coal-chute, the only difference being in some of the mechanical details of operation. It is a coal chute that has been used to a great extent, and in every case has given entire satisfaction.

The bills of material and large drawings of all the iron work necessary will be given in the next chapter.

(TO BE CONTINUED.)

GEODETIC WORK IN FRANCE.

(From the *Revue Scientifique*.)

THE Direction of the Geographical Service of the French Army has published an extended notice, which completes the very interesting collection which it has presented in the Exposition, and which enables the reader to appreciate fully the value and interest of that collection. This notice, which is edited with much care and published in magnificent style, is in two parts. Part I is devoted to historical documents and descriptions of the instruments and the maps shown. Part II gives a series of extracts from the maps prepared by the Service, 27 in number, running from the map of the Pyrenees made by Roussel in 1730, to the map of Africa recently published. The whole notice together gives a very satisfactory idea of the progress made in Geodesy and in map-making in the last two centuries, and this notice will preserve the information given after the Exposition is over and the exhibit has been removed.

To speak of both the notice and the exhibit together, we may say that it is divided into two principal parts, one historical and one showing the present condition of the science. Each of these two parts is divided into two distinct subdivisions, the instruments and maps—that is to say, the means and the result.

I.—THE INSTRUMENTS.

The instruments shown include all the branches of the art of surveying and measuring the earth, from those of precision, intended to establish the groundwork of the map, down to the smallest operations of leveling and of detail.

To take the historical portion, it is to the old Academy of Sciences that the honor of executing the first geodetic operations on a large scale belongs.*

In 1669 Picard measured for the first time a degree of the meridian of Paris, and not long afterward Cassini extended this measurement to all that part of the meridian which traverses France. Some years later two parties of French astronomers—one in Peru and the other in Lapland—measured arcs of the meridian in different latitudes. Still later Cassini revised the meridian of France, and La Caille went to the Cape of Good Hope to verify the measurement of the length of a degree.

In 1790 Delambre and Mechain determined once more the grand meridian of France, continuing their observations as far as Barcelona, with the object of obtaining the length of an arc of the meridian, from which the actual dimensions of the earth could be obtained, and from which they could establish, according to the ideas then received, the basic unit of the metric system. Soon after this meridian was extended still further by Biot and Arago.

The geographical engineers, successors of the astronomers of the Academy, have extended their work; they have based geodetic operations of the highest class upon a great series of triangles extending without interruption from Dunkerque to Formentera. This triangulation serves as a base for the great map of France, and as the beginning of that great system which, carried out since 1831 by the officers of the General Staff, forms triangulations of the second and the third order, which cover the entire territory.

For a long time the methods and observations of calcu-

lations established by Delambre and applied with success by his followers had been considered as attaining the limits of perfection. Abroad they have served as a point of departure for the new methods of Gauss and Bessel.

More lately, however, the introduction into geodetic science of the new methods, and the progress made in the construction of instruments, have brought our modern work to such a degree of perfection that we are forced to admit errors in the former French system.

With the object of eliminating these errors, the Ministry of War in 1869 ordered a new measurement of the meridian of France. This measurement, continued for 18 years under the direction of General Perrier, is now complete, and it will be supplemented by new measurements of the entire system, wherever the new meridian has shown errors. The work of revision of the base lines of the map of France will be completed by measurements of latitude, longitude, and azimuths, a part of which is already done.

In order to carry out these different works of great precision, and also to form the base of the new map of Algeria and Tunis, the Geographical Service has been obliged to renew its material of observation. The method of reiteration has replaced, in instruments intended to measure angles, the method of repetition, and the apparatus for measuring base-lines has been constructed on the new method invented by Porro, while to determine the coordinates the most delicate instruments and the most perfect methods have been borrowed from astronomers.

The perfection which has been obtained in instruments can only be realized from an inspection of the remarkable collection which forms the first part of the exhibit.

II.—CARTOGRAPHY.

The specimens of map work have been chosen in such a way as to form a general history of topography in France, from the beginning of the 18th century up to the present day.

In the historical exhibit there are placed all the works which preceded the publication in 1833 of the first volume of the great map of France to a scale of 1 : 80,000.

The modern exhibit is composed of all the maps prepared since that date.

This division is explained by the fact that the maps prepared since the Service passed under the charge of the General Staff of the Army mark a revolution in the history of topography.

In the 17th century and during part of the 18th century the conformation of the land was expressed on maps like a view in free perspective. This method, which for a long time retained partisans among distinguished geographers, consisted in putting in perspective the contour of the mountains, on little inclined planes gradually sloping down to the general plane. This was extended to the representation of rocks, woods, cities, villages and many other objects as far as their form and the scale of the map permitted. Bourcet's map of Dauphiné, dated 1760, is a type of the maps executed on this system.

Another plan used already before that date is that of lines of greatest fall. In this the geographer follows in imagination the curves which would be followed on the surface of the earth by a drop of rain or some other body subject to the laws of gravity. In this way the curves are determined and projected, so that the fall of the land is represented in every direction. This method, first used by Massé, Royal Engineer, in his map of Poitou, was followed by Cassini in his map of France.

The geographical engineers perfected this second method of representation, and adopted the principle of an oblique light, bringing strongly into relief the irregularities of the surface. The map of the Island of Corsica, on a scale of 1 : 200,000, may be considered one of their most remarkable works.

The map of France, on a scale of 1 : 80,000, is of the type of a fourth system, which is in reality only a modification of the one last described. The lines of engraving, following always the lines of greatest fall, are divided on a scale of falls established mathematically, but the light is supposed to strike the surface vertically and not obliquely.

For the last 20 years the method of representing the surface by horizontal curves or contour-lines tends to replace this method.

Moreover, the general preference at this time seems to be for maps printed in several colors, and there is also a demand for rapid execution. In consequence, the copperplate engraving of maps is gradually going out of date, and is being replaced by lithographic work, by zinc etching or engraving, and by the various heliographic methods. Specimens of all these different kinds of work are included in the exhibit.

The chief feature of the exhibit is the magnificent map of France, on a scale of 1 : 80,000. The execution of this new map, intended to replace the old map of Cassini, the imperfections of which were realized, was ordered in 1817, and the geodetic and topographical work began in the spring of the following year. The primary and secondary triangulations were completed in 1854, the triangulation of the third order in 1863, the topographical work in 1866, and the engraving in 1882. The field notes, on the scale of 1 : 40,000, were made by the officers of the Corps of Geographical Engineers attached to the General Staff, and the reduction to the scale of 1 : 80,000 was made by the draftsmen in the office of the Staff. The most striking feature of this great work, the total engraved surface of which covers 100 square meters, is the fact that it represents in all over 5,000 years of work, contributed by more than 800 officers, geographers, topographers, artists and engravers, and, nevertheless, the execution is characterized by complete harmony. The 273 separate leaves which compose it, engraved by over 65 different artists, seem to be executed by the same hand.

The dimensions of the map of France on a scale of 1 : 80,000—43.30 ft. in width by 40.35 ft. in height—have not permitted its representation on a single sheet. The specimen shown represents the frontier of the Alps from Grenoble to Nice.

We must close by some remarks on the work undertaken of constructing a new topographical map of France on a scale of 1 : 50,000, in which the levels will be shown by equidistant contour-lines picked out with color. The specimen of this new map exhibited shows the northeastern frontier in the neighborhood of Metz.

The entire map when completed will consist of 950 sheets 25.20 × 15.75 in. in size. It is, in fact, the reproduction on this scale of the field notes made on the spot by the officers of the Staff, corrected from the geodetic work recently completed and now in progress. It will be engraved on zinc and printed in six colors. Red will be used for buildings and for roads regularly maintained and always passable for carriages. Black is used for roads not always passable, for municipal boundaries, farm divisions, etc., and for all lettering. The water is represented by blue; forest or woodland by green, and the contour curves are drawn in mineral brown, picked out with bluish gray. The distances between the regular horizontal curves which express the contour of the surface is 32.8 ft. (10 meters), and the lines are lightly traced in order to prevent confusion of details.

From a practical point of view this map will present certain advantages over the existing ones. The use of different colors to represent hills and mountain land and the large scale will make it very easy to read. The representation of the surface by equidistant contour-lines will not hide, as the engraved lines do, especially in mountain districts, the details of the surface. And this method of representation will enable hereafter engineers, geologists and others to utilize the maps given out to the public, relieving them from the trouble they have been under heretofore of going to the office of the Geographical Service to obtain the preliminary plotting made from the field notes.

The exclusive use of contour-lines for the representation of mountains or hills presents the inconvenience of depriving them of relief and of making the different irregularities of the surface so much alike as to render a comparison by the eye almost impossible. If, for instance, in very rapid falls, the simple nearness of the curves is sufficient to give a certain relief to the general form, it is not the same in the less irregular parts of the surface; there the eye has difficulty in following the lines and the map can only be read, for level country, by close and difficult study.

To obviate this inconvenience, which is found in all maps in which the contour-lines alone are used, the Geographical Service has sought to represent the outline of the surface by a careful variation of color, taken on the assumption of light falling vertically, and regulated in such a way that the shade is deepened directly in proportion to the fall. It has also endeavored to determine the shades of color in such a way as not to interfere with the other details of the map, and especially with the lines representing the system of roads. For this reason it has been decided that inclinations less than 1 : 40 shall not have any special color.

The coloring is executed by the lithographic crayon, and is made by a sixth impression plate.

The specimen shown has been executed after the principles described above, and has a most excellent effect in every way.

Finally it may be said that this exhibit of the Geographical Service of the Army is one of the most interesting in the Exposition, and does great honor to the officers under whose charge the work is conducted.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 338.)

CHAPTER XXXIII.

RUNNING LOCOMOTIVES.

QUESTION 787. *Before starting the fire in a locomotive what should be observed?*

Answer. It should always be noticed before kindling the fire whether the boiler has the requisite quantity of water in it; that all cinders, clinkers and ashes are removed from the grates and ash-pan, and from the brick-arch or water-table, if the boiler has either of these appliances; that the grates and drop-door are in their proper position and securely fastened; that the throttle-valve is closed and the lever secured; and, if the boiler was filled through the feed-pipe by means of the engine-house hose, it should be observed whether the check-valves are closed. If they are not closed it will be shown by the escape of water when the engine-house hose is detached, or by the water and steam blowing back into the tank when the tender-hose are coupled up, and after steam is generated in the boiler. Locomotive boilers are sometimes seriously injured by building a fire in them when they have not been filled with water. This can only occur from the grossest carelessness on the part of the person who starts the fire, and is or should be a cause for suspension or discharge of the person who is guilty of such neglect. In filling a boiler it must be remembered, however, that when the water is heated it will expand, and that when bubbles of steam are formed they will mix with the water and thus increase its volume, so that after the water is heated its surface, as shown by the water-gauge and gauge-cocks, will be considerably higher than when it is cold.

QUESTION 788. *How should the fire in a locomotive be started?*

Answer. It should be started slowly, so as not to heat any one part suddenly. Probably the greatest strains which a locomotive boiler has to bear are those due to the unequal expansion and contraction of its different parts. When the fire is started, of course the parts exposed to it are heated first, and consequently expand before the others do. If the fire is kindled rapidly, the heating surfaces will become very hot before the heat is communicated to the parts not exposed to the fire. Thus the tubes, for example, will be expanded so as to be somewhat longer than the outside shell of the boiler, and therefore there will be a severe strain on the tube-plates, which will be communicated to the fire-box, stay-bolts, braces, etc. The inside plates of the fire-box will also become much hotter than those on the outside, and as they are rigidly fastened to the bar to which both the inside and the outside shells are fastened at the bottom the expansion of the inside plates will all be upward, which thus strains the stay bolts in that direction. As the motion due to this expansion is greatest near the top of the fire-box, the top stay-bolts are of course strained the most, and it is those in that position, as has already been pointed out, which are the most liable to break. When steel plates are used the expansion or contraction sometimes cracks them, and occasionally hours after the fire is withdrawn from the fire-box, the inside plates will crack with a report like that of a pistol. It is, therefore, very important both to heat and cool a locomotive boiler slowly, and it is best to kindle the fire several hours before the engine starts on its run.

QUESTION 789. *If the fire in the fire-box has been banked, what should be done before leaving the engine-house?*

Answer. The fire should be broken up with a bar and the ashes shaken out of it, and fresh coal should be thrown on the fire if it is needed.

QUESTION 790. *What should be done when the locomotive leaves the engine-house and before the train is started?*

Answer. Before leaving the engine-house the cylinder cocks should be open, so that any water or steam which is condensed in warming the cylinders can escape. The engineer should know that the tank is filled with water, the sand-box with sand, and that there is a proper supply of oil, waste, packing, tools, and lamps on the engine. Before the engine is started from the engine-house the bell should be rung and time enough allowed for any workmen employed about the engine to get out of the way. This rule must be scrupulously obeyed under *all circumstances*, and a locomotive should *never* be started without first giving such a signal. Without it there is always danger that some one about the engine will be hurt or killed. While running from the engine-house to the train the engineer should observe very carefully the working of all the parts of his engine, and as far as possible see that they are in good working condition. If the engine is without a steam or air brake, the fireman should operate the hand brake on the tender when it is needed. The junction with the train, especially when it is a passenger train, should be made very gently, as otherwise passengers may be injured by the shock. Before starting the engineer should see *himself* that the engine and tender are securely coupled together, that the frictional parts are properly lubricated, as explained heretofore, that the fire is in good condition, and that the requisite quantity of steam has been generated. If the steam is too low, the blower should be started, which stimulates the fire. He should also test the air-brakes, as explained in another chapter.

QUESTION 791. *When the train is ready, how should the engine be started?*

Answer. After the signal to start is given by the conductor, the engineer also gives a signal by either ringing the bell or blowing the whistle. The latter should, however, be used, especially at stations, as little as possible, on account of the risk of frightening horses and the shock which it produces on persons who are unaccustomed to hearing it, or are suffering from any nervous disorder. After giving the requisite signal, the engineer places the reverse lever so that the valve will work either in full gear or very near it. He then opens the throttle *slowly* and *cautiously* so as to start the train gradually. If the train is a very heavy one, it is best to back the engine so as just to "take up the slack of the train"—that is, to push the cars together so that there will be no space between them, and thus compress the car draw-springs. When the cars stand in this way, those at the front end of the train are started one after another, which makes the start easier than it would be if it were necessary to start them all at once. If the throttle is opened too rapidly, the driving-wheels are apt to slip, but with a very heavy train, even with the greatest care, this is liable to occur. If the train cannot be started otherwise, the rails must be sanded by opening the valves in the sand-box. As little sand should be used as possible, because the resistance of cars running on sanded rails is greater than on clean rails, and thus the train is more difficult to draw after it reaches the rails to which sand has been applied. The difficulty to be overcome may thus be increased by the means employed to overcome it.

While the train is slowly set in motion the fireman and engineer should ascertain by watching whether the whole train moves together, and that none of the couplings are broken in starting, and also whether any signal is given to stop, as is sometimes necessary after the train has started. On leaving the station he should observe whether all the signals indicate that the track is clear and that the switches are set right, and also look out for obstructions on the track. The train should always be run slowly and cautiously until it has passed all the frogs, switches and crossings of the station yard, and not until then, and when the engineer has seen that everything is in order, should he run at full speed. As the engine gains in speed the reverse lever should be thrown back and nearer the center of the quadrant or sector, so as to cut off "shorter."

QUESTION 792. *After the engine is started, how can it be run most economically?*

Answer. The advantage of using steam expansively has already been explained in Chapter V; it is more economical to use steam of a high pressure, which is done by keeping the throttle-valve wide open, and then regulating the speed by cut-

ting off shorter—that is, expanding it more—than it is to throttle the steam. If the speed is reduced by partly closing the throttle-valve, the steam is wire-drawn, and, as was shown in answer to Question 101, it then produces less useful effect than it would if it was admitted into the cylinder at full boiler pressure.

There is also another practical difficulty in using steam of a high pressure and running with the throttle wide open and regulating the speed with the reverse lever alone. The link-motion, as has already been explained, will not be effective in cutting off at a point below about one-quarter of the stroke. Now it often happens, even when cutting off at that short point, with light trains on a level or slightly descending grade, that the speed will be too great if the throttle is wide open and with full steam pressure in the boiler. When this is the case, it is absolutely necessary to reduce the speed by partly closing the throttle. Undoubtedly if valve gear for locomotives was so constructed that steam could be cut off effectively at a shorter point of the stroke, it would result in some increased economy in the use of steam.

The engineer should aim to run at as nearly uniform speed as possible, and in order to do so should divide the distance between stopping points and the time given for running it into as small divisions as he conveniently can, so as to be able to tell as often as possible whether he is running too fast or too slow, and thus travel over the shorter spaces in corresponding periods of time.

QUESTION 793. *How should the boiler be fed?*

Answer. The feeding of the boiler should, if possible, be continuous, and the quantity of water pumped into it should be adjusted to the amount of work which the engine is doing. Ordinarily one pump or injector is more than sufficient for feeding the boiler, so that usually only the one on the right side of the engine, where the engineer stands, is used. The flow of the water with a pump is regulated by partly opening or closing the feed-cock. In feeding the boiler it must be seen that the water is neither too high nor too low. If it is too low there will be danger of overheating the crown-plates or even of an explosion; if it is too high, the steam space in the boiler is diminished unnecessarily, and will cause the water to rise in the form of a spray, and thus be carried into the cylinders with the steam, or the boiler will *prime* or *foam*, as it is called. This water, if it collects in the cylinder as already explained, may by the concussion produced by the motion of the piston break the cylinder.

QUESTION 794. *What is the cause of priming in a boiler?*

Answer. One of the chief causes of priming is impure water. If grease, oil, or soap gets into the boiler, it is almost sure to cause priming. Mud or other dirt is also liable to cause it. It is often due to the difference in the temperature and pressure in the water below and the steam above. Thus, if we have a boiler in which the water is heated to a temperature due to 150 lbs. effective pressure, or 366 degrees, and we then open the throttle-valve suddenly, so as to relieve the pressure on top of the water, there will at once be a rapid generation of steam in the water which will rush to fill the space from which the steam has been drawn, just as the gas in soda water will rush toward the mouth of a bottle when the cork is drawn. This newly-generated steam will be formed at the hottest part of the boiler first —that is, next to the heating surface. It will, therefore, happen that as soon as the pressure is relieved, bubbles of steam from all parts of the heating surface of the boiler will flow to the point at which the steam escapes. The motion of these bubbles will be so rapid that large quantities of water will be carried with them. The same thing will also occur if the heat of the water is increased very rapidly. The water will then become hotter than the temperature, due to the pressure of the steam above it, and consequently there will be a rapid formation and escape of bubbles of steam from the water, which will thus have the same effect as they would have if the steam pressure was reduced.

The amount of water carried up with the steam is increased if the escape of the latter is obstructed in any way, owing to imperfect circulation of water in the boiler, or by floating impurities, such as oil, on the surface. When this condition of things exists, the ebullition is, as it were, convulsive, and the water is thus carried up with the steam when it escapes. Priming is also probably due in some measure to the flow of steam over the surface of the water to the point of outflow,* carrying particles of water with it just as a high wind will, when blowing over the crests of the waves of the sea.

When steam is drawn, as it usually is in locomotives, from the top of the dome to which the safety-valves are attached, the tendency to prime is very much increased when they are blowing off, so that some engineers advocate the use of two domes, from both of which the supply of steam is sometimes drawn, and in other cases the safety-valves are mounted on one, and the steam-pipe is placed in another dome. Whenever the safety-valves begin blowing off steam, the pressure in the boiler should be reduced as soon as possible, not only because when they are blowing off it tends to produce priming, but because the steam which escapes from them is wasted. The pressure can be most economically reduced either by increasing the amount of water which is fed into the boiler, or by opening the heater cocks and allowing the steam to escape into the tank and thus warm the water in the tank. If the boiler is too full, the former method cannot be employed, and in heating the water in the tank the engineer must be careful not to get it too hot, because in that case neither the pumps nor the injectors will work satisfactorily, and the paint on the tenders is also liable to be blistered and destroyed by the heat. By feeling the tank with the hand it can soon be discovered whether the water is too hot. If the steam pressure cannot be reduced in any other way, the furnace door must be partly opened.

The use of muddy water will also sometimes cause a boiler to prime. It is probable that priming is sometimes due to the formation of foam on the surface of the water, and therefore all priming is often called foaming; whereas it is thought that often a boiler will prime when the water does not foam. More accurate information regarding the priming of boilers is, however, much needed, as many of the phenomena have thus far not been satisfactorily explained. The principal causes of priming in ordinary practice are, however, undoubtedly owing to defective circulation, too little steam room, impure water, or too much water in the boiler.

QUESTION 795. *How can it be known whether an engine is priming, and what should be done to prevent it?*

Answer. The priming of a boiler can be known by the white appearance of the steam which escapes from the chimney and the cylinder cocks. Dry steam always has a bluish color. When an engine primes or works water into the cylinders, it is usually indicated by a peculiar muffled or dead sound of the exhaust, which from this cause loses its distinctly defined and sharp sound. This can be observed best when the furnace door is opened. It is also indicated by the discharge from the gauge-cock, as the steam from the upper cocks is not clear, but is mixed with water. To use a phrase employed by practical men, the priming or foaming of the boiler may be known by the "flutter" of the gauge-cocks. The water will also rise in the glass water-gauge, and it will not indicate correctly the quantity of water in the boiler. As soon as there are any indications of priming, foaming, or that water is working into the cylinders, the cylinder cocks should be opened at once, otherwise the cylinders, cylinder heads, or pistons may be broken. The throttle-valve should be either partly or entirely closed. When the latter is done the foaming will in most cases cease for the time, so that the engineer can tell how much "solid" water there is in the boiler. When the flow of steam from the boiler is stopped the priming usually stops, and the true level of the water will be shown by the gauge-cocks and glass water-gauge. If it is found that there is too much water in the boiler, it is best to shut off the feed, and in some cases the blow-off cock should be opened. The latter is, however, attended with some danger, because if any obstruction should get into the blow-off cock, or it should stick fast, so that it could not be closed, all the water would escape from the boiler, and with a heavy fire in the fire-box there would be great danger of overheating, and thus injuring the boiler or of "burning" it, as it is ordinarily termed. In that event it will be imperative to put out the fire at once. Another method of affording relief, if a boiler foams, is to place what is called a *surface-cock* in the back end of the fire-box, about half way between the upper and lower gauge-cocks. With such a cock, the water can be blown off from the surface instead of from the bottom. As foaming or priming is often caused by oil or other floating impurities on the surface, they can be blown out of the boiler with this arrangement, whereas, if the water escapes from the bottom of the boiler, the floating impurities will always remain after it is blown off. A perforated pipe, which extends for some distance along the surface of the water inside the boiler, is sometimes attached to the surface-cock, so that the water which is blown off will be drawn from a number of points along the surface. If it is essential to keep the train in motion when the boiler foams, it is a good plan to place the reverse lever in full gear and open the throttle-valve very little, so as to diminish and equalize the flow of steam into the cylinders.

If the steam is rising rapidly when foaming begins, it will be well to cool the boiler off by opening the furnace door part way. This means of relief, as mentioned before, should, however, be used as little as possible, because there is always danger of causing the tubes or other parts of the boiler to leak, by either heating or cooling suddenly or rapidly. If the engine primes when there is but little water in the boiler, and at a time when the steam

* Wilson on Steam Boilers.

is rising rapidly, it may sometimes be remedied by increasing the amount of feed-water, and thus partly cooling the water inside. The use of pure water, careful firing so as to keep the steam pressure regular, feeding the boiler so that the level of the water will be nearly uniform, and then starting the engine carefully —that is, opening the throttle-valve gradually, are the most effective means in practice of preventing a locomotive boiler from priming.

QUESTION 796. *What is the economical effect of priming on the consumption of fuel in locomotives?*

Answer. It causes a great waste of heat, first by the escape of that contained in the hot water which passes through the cylinders and which does no work, and second, when steam is mixed with a great deal of water, it will not flow either to or from the cylinders as quickly or easily as dry steam will. Consequently the initial pressure on the piston, if the engine is running even moderately fast, and is cutting off short, will not be so great as it would be if dry steam was used. Wet steam is also more difficult to exhaust from the cylinders than that which is dry, and therefore the back pressure on the piston is greater when the boiler primes than when dry steam alone is used.

QUESTION 797. *When running on the open road, what should the locomotive engineer observe?*

Answer. Either he or the fireman should *constantly* watch the track in front of them, and also observe, from time to time, whether the train of cars, especially if it is a long one which he is handling, is in good condition. HE MUST OBSERVE EVERY SIGNAL SCRUPULOUSLY, AND SHOULD NEVER PASS ONE UNTIL HE IS SURE THAT HE IS AUTHORIZED TO DO SO. The well-known maxim, "Be sure you are right; then go ahead," should be changed for locomotive engineers to, DON'T GO AHEAD UNTIL YOU ARE SURE YOU ARE RIGHT, AND WHEN IN DOUBT ALWAYS CHOOSE THE SIDE OF SAFETY. In running through a curve, the speed of the train should always be moderated in proportion to the sharpness of the curve, and before reaching it, as the train has a tendency to continue in a straight line, and there is thus danger of running off the track. The higher the speed, of course, the greater is the resistance which is required to prevent the train from running in a straight line, and consequently the greater is the strain which is thrown on the flanges of the wheels and on the rails and axles. On a curve it is also impossible, usually, to see further than a short distance ahead, and therefore, if the train is running very fast, it cannot be stopped in time, should there be any obstruction or danger on the track.

QUESTION 798. *What precautions should be observed in running over steep grades?*

Answer. On approaching an ascending grade the fireman should see that the fire is in good condition, and as much coal should be put on it as can be burned to advantage. The engineer should also fill the boiler as full of water as he safely can, without danger of priming, and should heat this water as hot as possible without blowing off steam at the safety-valves. The object of this is to have a supply of water already heated before reaching the grade. If, as often happens with a heavy train, the boiler will not make as much steam as the engine consumes, if there is a large supply of hot water in the boiler it can be used as a reserve, should it be necessary to do so, without danger of injury to the boiler. If there was so little water in the boiler that it would be dangerous to allow it to get lower, then it would be necessary to feed cold water as rapidly as the hot water escaped in the form of steam. When the engine is working hard, it is often impossible to heat all this cold water as fast as it is pumped into the boiler, without reducing the steam pressure until there is not sufficient power to pull the train. If, however, there is a supply of hot water in the boiler, at the critical point on the grade, where the engine is most liable to fail, the pump or injector can be partly shut off, and thus less water will be fed into the boiler, and the steam pressure will be maintained without danger. Undoubtedly it is better to feed locomotive boilers uniformly, if that is possible, but it often happens that a reserve supply of hot water in the boiler enables an engine to pull a train up the most difficult place, whereas, without such a supply, the locomotive would stick fast. As the capacity of locomotives is rated on nearly all roads by the number of cars they can "pull up the hill," of course whatever aids them at the critical point increases their capacity. This fact gives engines with large boilers much advantage over those with small ones.

In running up steep grades, allowance should alwaysbe made for the effect of the inclination of the track upon the position of the water surface in the boiler, and also the fact that as soon as the throttle-valve is closed, and steam shut off, the surface of the water will be considerably lower than when the engine was working hard. On a grade of 50 ft. to a mile, the front end of the tubes of an ordinary locomotive would be about 2 in. higher than the back end of the crown-sheet. If, then, on working hard up such a grade, it is succeeded by another of equal descent, the front ends of the tubes would be 2 in. *lower* than the back end of the fire-box, so that if the crown-sheet was covered with 2 in. of water just before reaching the top, it would be exposed to the fire as soon as the engine reached the descent. This exposure would be dangerous, because not only would the water be 2 in. lower over the crown-sheet, but it would fall considerably more when the throttle-valve was closed. These considerations will show the danger of running the water too low while ascending steep grades.

In pulling trains up steep grades, especial caution should be exercised to prevent any of the cars from breaking loose from the train, because such an accident may cause great disaster.

If the engine is not equipped with an automatic cylinder oiler, as soon as the top of the grade is reached the fireman should oil the main valves, because it can only be done when steam is shut off, as the oil will not run into the steam-chest when there is a pressure of steam in it; and as the valves are always subjected to the severest wear while pulling up a steep grade, the valves and valve-faces are apt to become dry. As saturated steam to some extent prevents valves from cutting, it is not so important that they be lubricated while the engine is working with steam, but as soon as steam is shut off they should be oiled, otherwise there is danger of their being injured by their friction on the valve-seats.

In running down grades, the engineer has the greatest possible cause for using every precaution, because not only is the train much more difficult to control, but usually frequent sharp curves prevent a view of the track for any considerable distance ahead. He should, therefore, watch the track in front of him with the greatest vigilance, so as to be ready to give the requisite signals to the brakemen to apply the brakes, or, if the engine and train are provided with continuous brakes, to apply the latter, or even reverse his engine, in case of danger.

QUESTION 799. *What must be done on approaching a drawbridge or a crossing of another railroad at the same level?*

Answer. In many of the States it is provided by law that all trains must come to a *dead stop* before crossing a drawbridge or another railroad at the same level. When interlocking signals are provided at such places it is not considered essential to stop, but the engineer should then be absolutely certain that the signals indicate that the line is clear, and he should approach such places with his train under sufficient control, so that he can stop it in case of danger. The train should under no circumstances run up to such points until a signal has been given that the line is clear. An engineer should *never assume* that the signal has been given, nor take another person's word for it, but should see and know it himself. In some conditions of the weather, and with the light falling on a signal in certain directions, it is sometimes difficult to determine its color or form. If there is any doubt about it, the testimony of another person should always be sought. There is good reason for believing that color-blindness – that is, an incapacity for distinguishing one color from another, is a more common infirmity than is usually supposed. It is certain, too, that people who ordinarily distinguish colors very accurately are subject to color-blindness in certain conditions of health, and that it is sometimes the result of overwork or great weariness; and a case is recorded of a person who was always color-blind after a debauch. There are, therefore, good reasons why a locomotive engineer should not always place too implicit confidence in what he "sees with his own eyes," but if he has any doubt, he should take the "benefit of the doubt," which should always lead him to take the side of safety.

QUESTION 800. *How should the engine and train be managed in running into a station?*

Answer. First of all, when running into a station, when the train stops the speed must be checked so that the train will not enter with very great momentum. Therefore, at a distance varying, according to the nature of the grades and track, the steam should be shut off, so that the speed will be reduced so much that the train under any circumstances will be under full control. It is always better to enter a station at too low a speed than to run in too fast, because if it is necessary, more steam can always be admitted to the cylinders to increase the speed before coming to a stop; whereas it is not so easy to stop the train if it is running too fast, and it becomes necessary to check it before entering the station. This will sometimes be necessary, because it may readily happen through negligence or accident at stations that in switching cars one or more may be left standing wholly or partly on the track, which the arriving train must run over, in which case a collision, with its terrible consequences, may be unavoidable. When steam is shut off the reverse lever should be thrown into full gear, because in that position there is less compression of steam in the cylinders, and therefore not so much liability of raising the valve from its seat.

When a train is equipped with continuous brakes, the control which they usually give to a locomotive engineer over the train

is so great that he is apt to approach stations, crossings or drawbridges at a high rate of speed, and rely on such brakes to stop the train. This practice is always attended with danger, because if it was found, on getting near to the station, crossing or drawbridge, that the track was not clear, and that it was obstructed by a car or train, or the draw was open, if the engineer should attempt to apply the brakes and from some cause they should fail to work, as sometimes occurs, then a collision or other disaster would be inevitable, because it would be impossible to stop the train with the ordinary hand-brakes. For this reason a locomotive engineer should always approach such places cautiously and with his train under sufficient control, so that if he finds there is danger ahead he can stop the train with the ordinary means, or at the worst by reversing the engine. Continuous brakes should always, excepting in cases of imminent danger, be applied gradually, so as not to check the cars with a jerk or too suddenly. The practice of opening the engineer's-valve, which was formerly used with the Westinghouse brake, suddenly, and then turning it back again as quickly, is almost sure to produce disagreeable and dangerous shocks to the cars. This cock should be opened gradually, so as to check the cars slowly at first. The new engineer's-valve, illustrated and described in answer to Question 647, is arranged so that air can be turned on and shut off quickly without producing disagreeable shocks.

QUESTION 801. *What must be attended to when running a locomotive at night?*

Answer. As soon as it begins to grow dark, the head-light must be lighted and properly trimmed, and the proper lamp signals placed in front of the engine, if the rules of the road require the display of such signals. A lamp should always be placed in the cab, so as to throw its light on the steam gauge, but not into the engineer's face, because he is unable to see distant signals so well if his eyes are exposed to the glare of a light near him.

At night, as objects which are passed cannot be seen distinctly, it is more difficult to tell the speed at which an engine is running than it is in the daytime. An engineer should, therefore, consult his watch frequently.

QUESTION 802. *What must be attended to in very cold weather?*

Answer. Great care must be exercised to prevent the water in the pumps, pipes and in the tender from freezing. If it does it will be almost certain to break the pump or burst the pipes. To avoid this the heater cocks must be opened, so as to keep the water in the tender warm. In excessively cold weather the engine should be run with greater caution than at other times, as iron is then more brittle, and also more liable to break, owing to the frozen condition and consequent solidity of the track.

QUESTION 803. *In running a locomotive in severe snow or rain-storms, what should be observed?*

Answer. Whenever it snows the pilot or cow-catcher should be covered with boards, or, better still, with sheet iron, so as to act like a snow plow. Brooms made of steel wire or scrapers should be placed in front of the front wheels of the engine, so as to clean the snow from the rails. The front damper on the ash-pan should be kept closed so as to exclude the snow from the ash-pan, which would soon fill it up, and in this way obstruct the draft. If the fall of snow is very heavy or it blows into drifts, the train must of necessity run very slowly, and even if a part of the track is clear of snow, it is unsafe to run fast on it, as there would be danger of throwing the engine off the rails, if it should run into a heavy drift at a high speed.

In severe rain-storms bridges, culverts, and such portions of the track as are liable to be washed away should be approached cautiously, especially at night. In both snow and rain-storms, and also in fogs, great caution is required, owing to the difficulty of seeing signals.

QUESTION 804. *What is meant by a reserve engine or "helper?"*

Answer. A *reserve engine* is a locomotive which is not employed in hauling a regular train, but is kept as a "reserve" to go to the help of an engine which may be compelled to stop on account of an accident of any kind, or to assist engines in moving trains up heavy grades, or is used in clearing away a wrecked train, rebuilding bridges, or other structures.

QUESTION 805. *What must be observed in running a reserve engine?*

Answer. As no special arrangements are usually made in preparing time-tables * for the running of reserve or, as they are usually called by railroad men, "*wild*" engines, it may very probably happen that it will be called upon to assist other engines when the road is not clear, and therefore its engineer must constantly be on the lookout for signals to stop, which are often given suddenly. He must switch off with special caution in order to be sure to keep out of the way of regular trains running in the opposite direction on the same track. When he reaches the train or place where the assistance of the reserve engine is needed, he must approach it *slowly* and *carefully*, in order to avoid a violent shock. On the return from the assisted train, he incurs the same danger, and must pay close attention to any signal to stop made to him by any opposite train on the same track, and also on his part warn such trains by the proper signals.

When a train is run with two engines, both in front of it, the forward one always takes the management of the train. The engineer of the hind engine must be guided by the signals of the engineer of the forward engine. In starting, the forward engine must be set in motion first and then the one behind it. In stopping, the steam must be shut off first in the hind engine. Likewise in decreasing the speed during the trip, the hind engine must first regulate the flow of steam. If these precautions are not observed the forward engine may easily be thrown from the track by the faster motion of the hind one. When there are two engines the air-brakes should always be operated from the front engine, but the air-pump on the rear one should be kept running to assist in charging the brake reservoirs with compressed air. When a train is assisted by a "helper" placed *behind* the train, and therefore pushing it, the forward engine must likewise be set in motion first, and steam should be let on in the hind engine only after a signal has been given by the engineer of the head engine. During the run both engines must move with the same speed.*

QUESTION 806. *How should switching engines be managed?*

Answer. In pushing and switching freight cars in a station-yard, they should be moved carefully and severe shocks must be avoided, as the cars, the goods with which they are loaded, and the persons employed about them may be injured by violent concussions. The engineer must also follow the instructions of his superior *strictly* and *cheerfully*, and should examine patiently and observe with discretion the suggestions of employés who are not his superiors.

In this service it is also of special importance that the engineer give a *distinct* signal with the whistle or bell before every movement of his engine, in order to warn in time those who at such times often stand on the track in the way of the engine or cars, or the persons engaged in loading, cleaning, or repairing the cars, and thus give them time to get out of the way.†

QUESTION 807. *In firing a locomotive, what are the most important ends to be attained?*

Answer. That which is of first and chief importance is to make steam enough, so that the locomotive can pull its train and "*make time*" ‡; second, it should make the requisite quantity of steam with the least consumption of coal, and third, with the least production of smoke, although the latter, independent of the economy of combustion, is considered of importance only with passenger trains. What is frequently lost sight of in considering this subject is the fact that with all locomotives it often happens that it is a matter of extreme difficulty to make enough steam to do the work required of the engines. When a freight train is struggling up a grade with a heavy train, or an express engine is obliged to make time under similar conditions, it often depends entirely upon the quantity of steam which can be generated in the boiler in a given time whether the engine will fail or not. In firing, therefore, the most important end to be aimed at is often simply to produce the largest amount of steam possible in a given time, even at the sacrifice of economy or by producing any quantity of smoke. Any means of economizing fuel or of smoke prevention, which reduces the steam-producing capacity of boilers, is therefore quite sure to be abandoned in time.

QUESTION 808. *How can a boiler be made to produce the largest quantity of steam in a given time?*

Answer. By burning the greatest quantity of fuel possible on the grate in that time. This can be done by keeping the grates free from clinkers and the ash-pan from ashes, and then distributing the coal evenly over the grates in a layer 6 to 12 in. thick. The thickness of the layer which will give the best results will, however, vary with the quality of the fuel, and must be determined by experience. If the layer is too thick, not enough air will pass through it to burn the coal. If it is too thin, then so much air will pass through that the temperature in the fire will be reduced. The rapidity of combustion will also be promoted by breaking up the coal into lumps the size of a man's fist or smaller. If fine coal is used it should be wet, otherwise it will be carried into the flues by the blast before it is burned,

* A *time-table* is a table which gives the time when each train shall arrive at the stations it passes, the stations at which it shall stop, and all the regulations by which it shall be run.

* Katechismus der Einrichtung und Betriebes der Locomotive, by Georg Kosak.

† Georg Kosak.

‡ The term *make time* means to run at the speed indicated on the time-table.

or caked, or even reaches the grate. Experience will indicate the amount of air which can advantageously be admitted above the fire in order to secure the maximum production of steam. The best size of the exhaust nozzles and the position of the petticoat-pipe must also be determined by experience. It will usually be found, however, that if enough air is admitted above the fire to prevent smoke, it will reduce the maximum amount of steam which can be generated in a given time. The fire should also be fed regularly and with comparatively small quantities of fuel at a time, although if the feeding is too frequent there is more loss from the cooling effect which results from the frequent opening of the furnace door than is gained from the regularity of the firing. In this, too, a fireman must consult experience to guide him.

QUESTION 809. *How can a locomotive be fired with the least consumption of coal?*

Answer. Two systems of firing are practised in this country, one known as the "banking system" and the other the "spreading system." When the banking system is employed, the coal is piled up at the back part of the fire-box, as shown in fig. 346, and slopes down toward the front of the grate, where the layer of coal is comparatively thin and in an active state of incandescence. The heap of coal behind is gradually coked by the heat in the fire-box, and the gases are thus expelled. Openings in the furnace door admit air, which mingles with the escaping gases, which then pass over the bright fire in front, and are thus supposed to be consumed. When the "bank" of coal behind becomes thoroughly coked, it is pushed forward on the bright fire and fresh coal is again put on behind to be coked. This system of firing is practised on some roads with good results, but it is doubtful whether it could be used successfully with coal which cakes and clinkers badly.

The spreading system is most commonly employed in the Western States, where the coal contains a great deal of clinker. When this is practised, the coal is spread evenly over the whole of the grate in a thin layer, and its success and economy depend upon the regularity and evenness with which this layer of coal is maintained and the fire fed. The thickness of the coal must be adapted to the working of the engine. When it is working lightly, the layer of coal should be thin, but when the engine is pulling hard the layer of coal must be thicker, otherwise the violent blast may lift the coal off the grates. The success of this system, as was explained in answer to Question 567, depends upon the manner in which the thickness of the fire is regulated, on the admission of the proper amount of air above the fire, and on the frequency with which the fire is supplied with coal. When this system of firing is employed not more than two shovelsful of coal should be put into the fire-box at once, and if the engine is not working hard, one or even less will be sufficient. The fireman must, however, determine by experience the thickness of fire, amount of air which should be admitted and the frequency of firing which will give the best results in practice. Doubtless these will vary with different kinds of fuel and the construction of engines. Usually the greatest obstacle in the way of producing good results is the fact that firemen would rather "take things easy" than exercise that diligence and observation which will alone insure success in any occupation.

QUESTION 810. *How can smoke be most effectually prevented?*

Answer. The means of preventing smoke were very fully explained in answer to Questions 580 and 581. It may be said briefly that this can be done only by properly regulating the supply of air which is admitted to the fire. The means of doing this have already been explained.

QUESTION 811. *What method of firing is employed when anthracite coal is used?*

Answer. The spreading system alone is then used.

QUESTION 812. *How may the rules which firemen should observe when bituminous coal is used be briefly stated?*

Answer. (1) Keep the grate, ash-pan and tubes clean. (2) Break the coal into small lumps. (3) Fire often and in small quantities. (4) Keep the furnace door open as little as possible. (5) Consult the steam-gauge frequently, and maintain a uniform steam pressure, and if necessary to reduce the pressure do it by closing the ash-pan dampers rather than by opening the furnace door.

QUESTION 813. *On arriving at a station where a train stops longer than a few minutes, what should the locomotive engineer and fireman attend to?*

Answer. The engineer should examine thoroughly all the parts of his engine, as has been heretofore explained. He should especially examine all the journals and wearing surfaces to see whether they are hot. This he can discover by feeling them. If any of them have become very much heated, they must be cooled by throwing cold water on them, and then thoroughly oiled. The working parts should be thoroughly lubricated, as already explained.

The fireman should examine the tank and see whether it is necessary to take in a fresh supply of water. He should then examine the grates and ash-pan, and clean the cinders and clinkers from the former, and the ashes from the latter. Neglecting to clean the ash-pan may result in melting and destroying the grate-bars, and by obstructing the admission of air to the grates, the ashes prevent the combustion from being as complete as it would be otherwise. With some kinds of fuel it is necessary to clean the tubes frequently, which must often be done at stations where the train stops.

During the stop, as thorough an inspection of the engine should be made by the engineer and fireman as the time will permit; but any unnecessary waste of time must be avoided, and the firing should be so managed that nothing need be done about it during the halt at the station. On starting again the same precautions should be exercised as on making the first start.

QUESTION 814. *After reaching the end of its run, how should an engine be cleaned and repaired?*

Answer. Before reaching the last station the firing should be so managed that there will be as little fire as possible remaining in the fire-box at the end of the run. After the arrival the engine should be run over a pit which is usually provided for the purpose, and the fire should be raked out of the fire-box by dropping the drop-door, if there is one to the grate, or turning the grate-bars edgewise, or withdrawing one or more of them, if it is necessary to do so. In this way the fire will fall into the ash-pan, from which it can easily be raked. After all the fire is withdrawn the dampers and furnace door should be closed so as not to allow the cold air to cool the fire-box and tubes too rapidly.

In order to keep the boiler clean—that is, as free as possible from sand, sediment or incrustation, it is necessary to blow it out frequently, if the water which is used contains much solid or incrustating matter. With "bad water" the boiler should be blown out as often as possible. On some roads this is done after each trip. In blowing a boiler out, the blow-off cocks must be left open, and after all the water has escaped the engine should be left to stand until it is cooled off. If there is any considerable accumulation of mud or sediment the hand-holes at the bottom of the fire-box and the cover to the mud-drum should be taken off, and as much of the mud removed as can be scraped out through those apertures. A hose-pipe attached to the hose of a force pump should then be inserted through these same openings, and a strong stream of water forced into the boiler. By this means much of the loose mud and scale will be washed out. The oftener this is repeated, of course, the cleaner can a boiler be kept. If a large amount of incrustation or mud has accumulated about the tubes, some or all of them must be taken out, so as to be able to remove the dirt.

After an engine is blown out, under no circumstances excepting absolute necessity should it be filled with cold water until it is cooled off. It should be remembered that any sudden change of temperature in a boiler subjects it to very great strains and incurs the danger of cracking the fire-box plates, or causing the tubes to leak.

The tender should also be cleaned of the mud which settles in it from time to time, but it is not necessary to do this as often as it is to clean the boiler. The strainers in the tank over the water-supply pipes should be examined and cleaned frequently. All the plates and flues should have the soot which sticks to them thoroughly cleaned off.

Although the cleaning of the boiler and the grates is usually committed to a special set of men, yet the locomotive engineer should examine them personally to see that it is properly done. He should pay attention to the condition of the grate, and see whether it is level and smooth. As soon as one or more of the bars are bent crooked, they usually burn out. If one of the bars is burned out the fire falls through the hole that it leaves into the ash-pan, and then the fire under the grate will heat it red hot, and finally may melt every bar. Every grate-bar which is only a little damaged or bent must therefore be removed as quickly as possible and replaced with a new one. An opening in the grate larger than the spaces between the bars allows a superfluous amount of cold air to enter the fire-box, and diminishes the steam-generating capacity of the boiler.

As soon as the engine is run into the engine-house, the cylinder cocks should be opened and left open while it is standing still, so that the condensed water can escape. All superfluous grease which has escaped from the wearing surfaces and the dust or mud which adheres to the engine should be wiped off with cotton waste or rags. This is usually done by men employed for the purpose. While they are doing this, they should examine every part thoroughly and observe whether it is in good condition, and if any defects are found they should be reported to the proper person whose business it is to have them repaired. As the faithfulness and skill of a fireman are often

estimated by the good or bad condition of his engine, he should, if for no other reason, take pains to keep it clean and everything in as good condition as possible.

If the engine is taken to pieces in order to be thoroughly repaired, the engineer, if he does not help to do this, should watch carefully the taking it apart and the putting it together again, as in this way he can become thoroughly familiar with the construction of the machine he runs.

QUESTION 815. *What precaution must be taken to prevent the water in a locomotive from freezing, if it is laid up?*

Answer. In very cold weather, if engines are laid up for any considerable time, no water must be left in the tender, boiler or any of the pipes. If, however, the engine must be soon used, and it is impracticable to let the water out of the boiler and tender, then, if exposed to the cold, a light fire must be kept in the boiler sufficient to make steam enough to warm the water in the tender. The water should, however, be drawn out of the pumps, injectors and the feed and supply pipes. This can be done by opening the pet-cocks, and closing the tender valves and uncoupling the hose, which will allow the water in the supply pipes to run out. By running the engine a few revolutions the pumps will then be emptied. The pipes and the pumps can also be prevented from freezing without uncoupling the hose, if the tender valves are closed and the pet-cocks opened, and steam is then admitted into the supply pipes by the heater-cocks. This forces part of the water which is in the pumps out of the pet-cocks and warms the rest. This, however, requires constant watchfulness to prevent freezing, and in excessively cold weather, if the engine must lay up for any considerable time, it is always best to empty the pumps and pipes.

(TO BE CONTINUED.)

Manufactures.

Udstad's Metallic Packing.

THE packing shown in the accompanying illustration has been tried and well tested on steam-engines and pumps, and has attracted considerable attention.

In fig. 1, *A A* are metallic rings of crescent-shaped section and *B B* rings of circular section made of some elastic composition. At present, the rings *B B* are made of canvas with a large rubber core.

The objects sought in designing this packing were as follows:

1. To make a packing which could be applied to any engine or pump without altering the present stuffing-boxes and glands.

2. To provide for some lateral motion of the rod in the stuffing-box. This is accomplished by the packing rings *B B*, which are protected from the direct action of the steam, and will thus always retain their elasticity. A proof that this claim is justified was shown in an engine to which the packing had been applied. The condensed water had not been properly drained off from the cylinder before starting the engine, and the piston, moving toward the back end first, had its motion suddenly arrested by the water, but the impact was partly relieved when the packing opened up around the rod, allowing part of the water to escape, and thus probably saving the cylinder-head.

3. To provide a number of angular grooves in the face of the packing, thereby making the steam condensed on the rod act as a lubricant.

4. To make a packing cheap in first cost, durable, and easy to repair or renew. The metallic rings are cut open at one place, as shown in fig. 4, and they are placed on the rod by partly opening them and twisting them sideways; afterward they are easily brought back to their original shape. These rings are made of Babbitt metal, of such composition as experience had shown to be best for this purpose. To ascertain if the rings could be decreased sufficiently by compression, a new ring, as shown in fig. 2, was put into a cylinder and pressure applied, when the inside diameter decreased ⅛ in., its final shape being about as shown in fig. 3. The ring was not cut open before this trial.

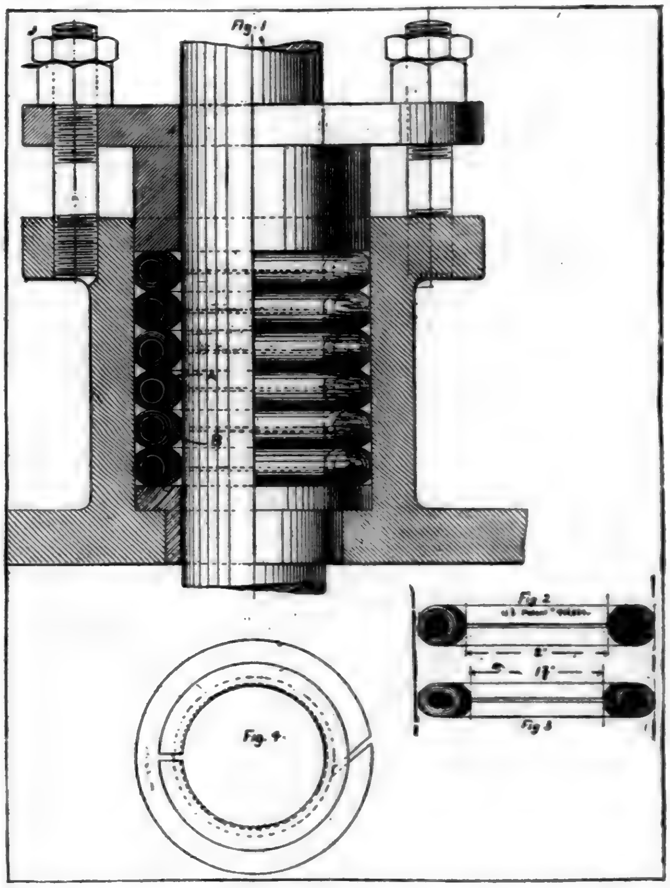
It is claimed that a good metallic packing causes less friction and consequent loss of power than a fibrous packing; for this reason a metallic packing will pay for itself in a short time without considering the further claim that it is easier to take care of and costs less when the time it will last is taken into account.

The packing illustrated has been in continual use for about 10 months, on a high-speed engine of 60 H.-P., and the piston rod is polished like a mirror. The nuts can frequently be tightened up with the fingers alone, without using a wrench, showing the small pressure required on the gland.

This packing is invented by Mr. S. Udstad, of Aurora, Ill., from whom further information in relation to it may be obtained.

Electrical Notes.

THE Electro-Automatic Rapid Transit Company, of Baltimore, on a two-mile experimental track, near Laurel, Md., has, it is stated, recently attained a speed of two miles per minute, with the moter and car. The object of this method of rapid transit is for the transportation of mails and light express matter, between large cities and the automatic control of the speed and stops from a central, or terminal station, without traveling attendants.



THE Westinghouse Electric Company, the Consolidated Electric Company, the United States Electric Company, the Westinghouse Electric Company of England, and various other smaller concerns have been consolidated under one charter, and will be known as the Westinghouse Electric & Manufacturing Company of Pittsburgh. The capital stock of the company is $5,000,000. The consolidated concerns have now 2,000 people employed. They manufacture 8,000 incandescent lamps per day, and they do a business of about $4,000,000 per year. The works in Pittsburgh are being enlarged.

THE East Cleveland Street Railroad recently opened a new extension on Prospect Street and Euclid Avenue, in Cleveland, O. The Company expects to operate 60 cars on this road as soon as the moters can be supplied, when the horses will all be removed from the line. This is an overhead conductor line, with the Sprague motor on the cars.

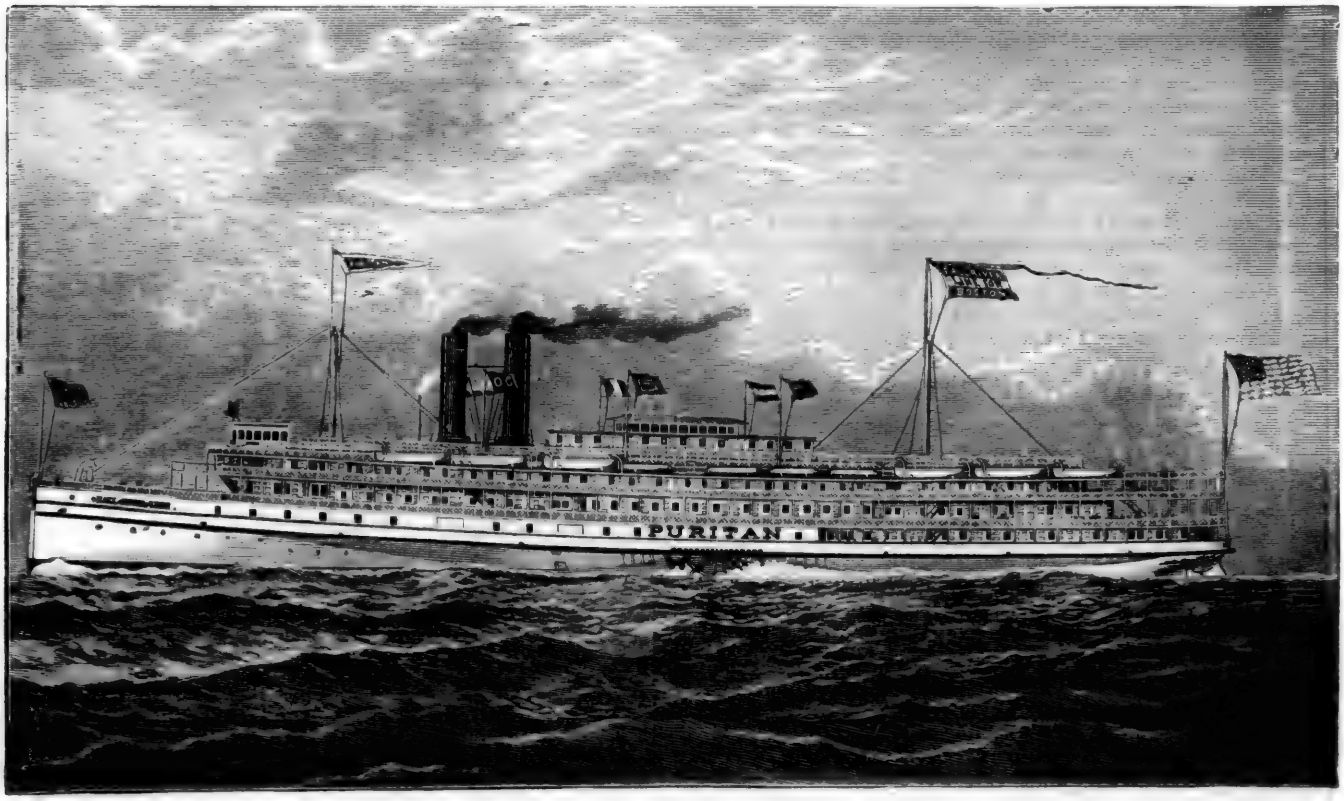
MR. JOSEPH SMITH, Director of the Julien Electric Traction Company, Limited, of England, has just effected an amalgamation of all the storage-battery companies and the chief electric-railway companies of England, under the name of the Electric Construction Corporation, Limited. In this amalgamation are included the following companies: the Julien Electric Company, Limited, of England; the Electric Power Storage Company, Limited, owning the Faure-Sellon-Volckmar patents, as well as being the parent company and licenser of the Electrical Accumulator Company of New York; the Elwell-Parker Company, Limited, being a large storage-battery company of England, and the rival for years of the Electric Power Storage Company, Limited; the Railway Electrical Contractors, Lim-

ited; the Sprague patents for electric traction and transmission of power. The capital stock of this new company consists of £500,000.

The Sound Steamer "Puritan."

The accompanying illustration represents the new steamboat *Puritan*, owned by the Old Colony Steamboat Company and run on the Fall River Line between New York and Boston. The *Puritan* is the largest boat of the kind in the world, and is completed and finished throughout in the best style, lighted with electric lights, and furnished with all the latest appliances for comfort and safety.

Some description of the boat has already been published, but the general dimensions are here repeated for convenient reference, as follows: Length over all, 420 ft.; width of hull, 52 ft.; extreme breadth over guards, 91 ft.; depth of hull amidships, 21 ft.; displacement, 4,650 tons. The hull is double, of steel, and divided into 59 water-tight compartments.



THE NEW SOUND STEAMBOAT "PURITAN."

The wheels are of steel, 35 ft. in diameter and have buckets 14 ft. long and 5 ft. wide, made of ¾-in. steel plate. They are feathering wheels and will be run at 24 revolutions per minute.

The *Puritan* has a compound, vertical beam, surface-condensing engine of 7,500 H. P. The high-pressure cylinder is 75 in. in diameter and 9 ft. stroke of piston. The low-pressure cylinder is 110 in. in diameter and 14 ft. stroke of piston. The surface condenser has 15,000 square feet of cooling surface, and weighs 53 tons. Of condenser tubes of brass there are 14½ miles in the *Puritan*. Her working-beam is the largest ever made, being 34 ft. in length from center to center, 17 ft. wide, and weighing 42 tons. When it is considered that the section of beam-strap measures 9½ by 11½ in., one may get an idea of the enormous strain and the strength of resistance of this beam. The main center of the beam is 19 in. in diameter in bearing. The shafts are 27 in. in diameter in main bearing, 30 in. in gunwale bearing, and are the largest ever made in this country. They weigh 40 tons each. The cranks weigh 9 tons each. The crank-pin is enormous, the bearing being 19 in. in diameter and 22 in. long. These immense forgings were made by the Cleveland City Forge Co., Cleveland, O.

She has eight steel boilers of the Redfield return tubular type, and the maximum working pressure is 110 lbs. to the square inch. Six of these boilers are 18 ft. 1 in. in width, and 15 ft. 2 in. long; the other two are 10 ft. wide and 14 ft. long. Each of the wide boilers has two shells; the narrow boilers have one each, 7 ft. 8 in. in diameter. The boilers contain 850 square feet of grate surface and 26,000 square feet of heating surface. The products of combustion pass through two superheaters, 8 ft. 10 in. inside diameter and 12 ft. 4 in. outside diameter, by 12 ft. high; thence into two smoke-stacks, the top of each being 101 ft. 1 in. from the keel. The fire-room is 78 by 12½ ft. There is a donkey boiler on the main deck for auxiliary purposes.

There are two centrifugal circulating pumps, each capable of throwing 10,000 gallons per minute. Besides these there are three other large pumps, with a combined capacity of 2,000 gallons per minute. Novel features are the three steam capstans, one forward and one on each quarter, to be used in docking the boat. Each capstan has a double cylinder engine, each cylinder 12 in. in diameter and 14-in. stroke. She has two Sturtevant blowers, furnishing fresh air for the fire-room, each capable of 50,000 ft. per minute. She will burn about 120 tons of coal on the trip from New York to Fall River and back.

The contract for the entire boat was taken by the W. & A. Fletcher Company, and the engine was built by that Company at its North River Iron Works in New York. The hull was built at Chester, Pa., by the Delaware River Ship & Engine Building Company. The joiner work was done by William Rowland, of New York, and the electric light plant was furnished by the Edison United Company.—*Marine Journal.*

Blast Furnaces of the United States.

The *American Manufacturer's* statement of the condition of the blast furnaces on July 1 is as follows:

Fuel.	In Blast. No.	In Blast. Weekly capacity.	Out of Blast. No.	Out of Blast. Weekly capacity.
Charcoal	63	11,204	101	13,350
Anthracite	90	31,848	99	25,944
Bituminous	131	89,356	115	54,260
Total	284	132,408	315	93,554

The appended table shows the number of furnaces in blast on July 1, 1889, and on July 1, 1888, with their weekly capacity:

Fuel.	July 1, 1889. No.	July 1, 1889. Weekly capacity.	July 1, 1888. No.	July 1, 1888. Weekly capacity.
Charcoal	63	11,204	68	12,753
Anthracite	90	31,848	96	28,176
Bituminous	131	89,356	119	74,743
Total	284	132,408	273	115,672

This shows an increase of 11 furnaces and of 16,736 tons weekly capacity this year over last year.

The Willans Triple-Expansion Engine.

(From the London *Engineer*.)

The accompanying illustrations show a triple-expansion engine on a new plan, constructed by Messrs. Willans & Robinson, of Thames-Ditton, England. The particular engine illustrated is one of 40 indicated H.-P., and was built to run a pumping engine. Fig. 1 shows on a small scale the engine as mounted in connection with a centrifugal pump; fig. 2 is a section through the engine showing its construction, and fig. 3 is a view of the piston-valve removed from its seat.

This engine is intended as a high-speed engine, and has run at from 450 to 550 revolutions per minute. The engines are single-acting—that is, steam acts upon the piston only during the down-stroke, the up-stroke being made by the momentum of the fly-wheel against an air-cushion in the lowest cylinder. The arrangement, it is claimed, renders high speed not only practicable, but also makes a very easy-running and durable engine, small ones of this pattern having been run for over two years with almost unappreciable wear on the bearings and piston-rings.

Fig. 1.

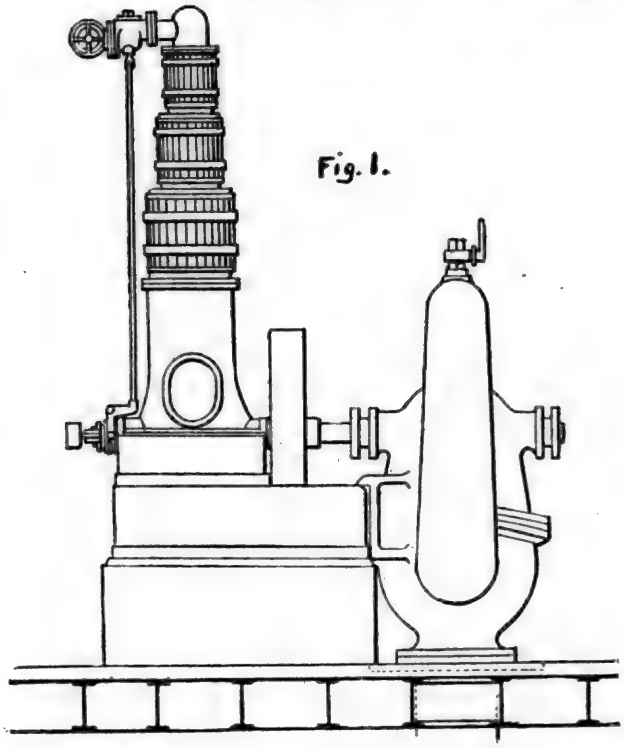
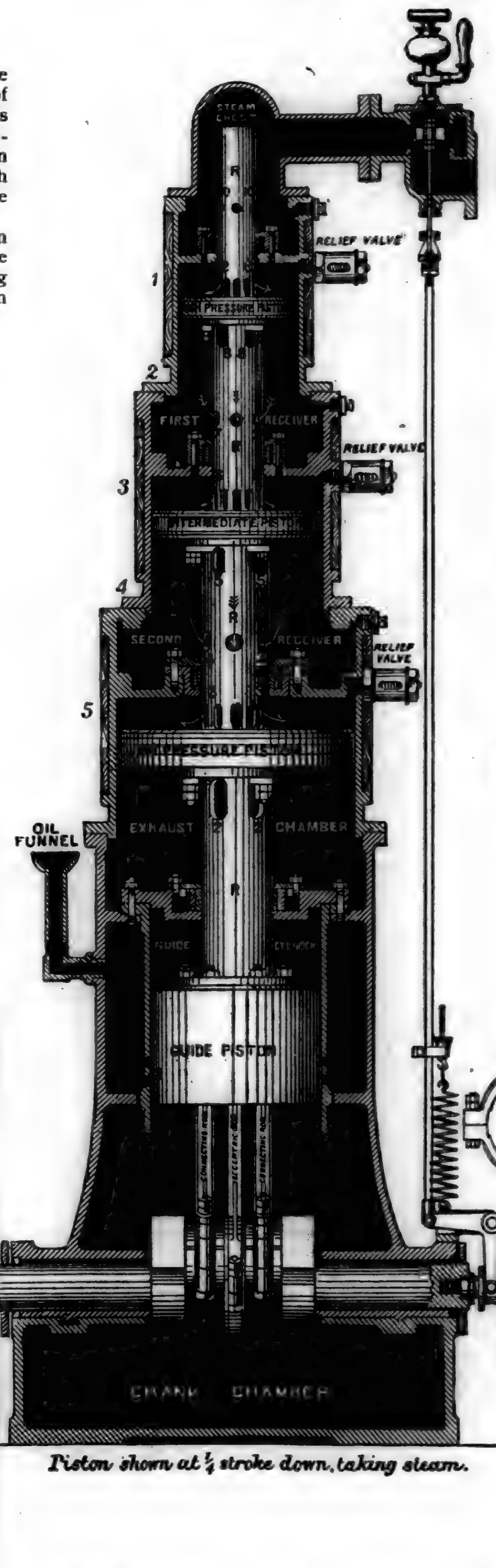
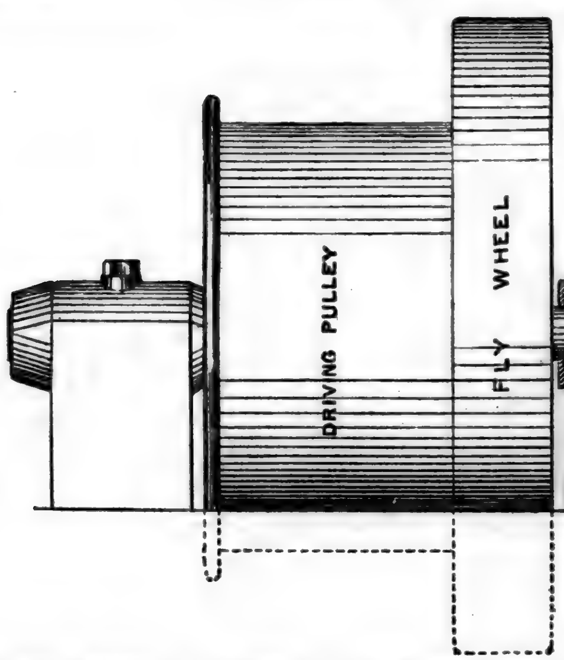
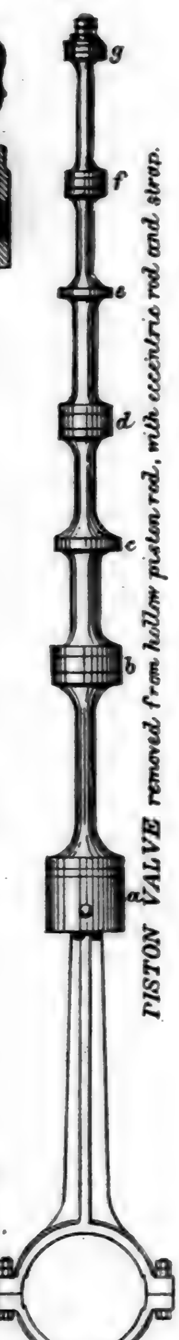


Fig. 2

Piston shown at ¼ stroke down, taking steam.

Fig. 3

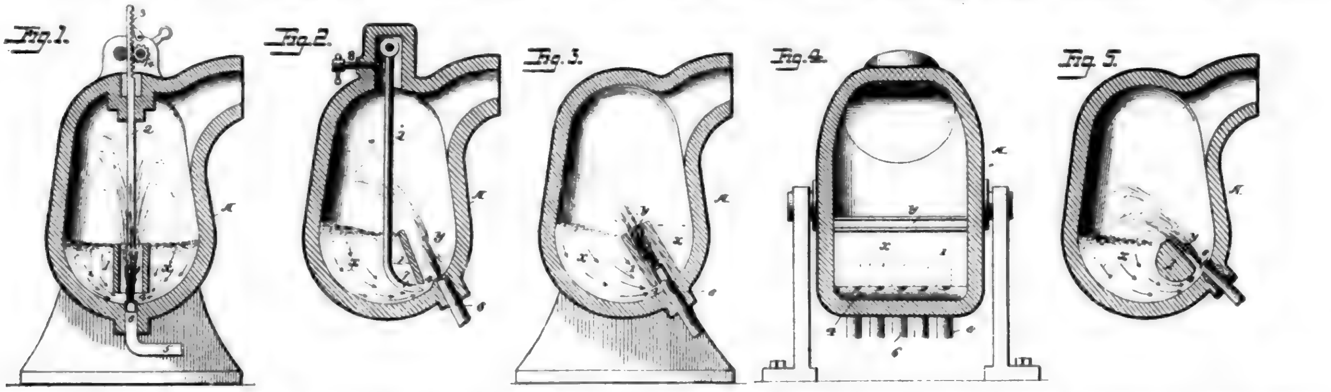


PISTON VALVE removed from hollow piston-rod, with eccentric rod and strap.

The crank-shaft revolves in a chamber filled to a certain height with lubricant—mixed water and oil—and splashes it in the form of a constant fine spray over the connecting-rods and movable parts; the lubrication is thus automatic, and the main bearings are continuously flooded with oil. In practice it is found that a very small amount of lubricant is sufficient. A full description of the engine is given below.

Fig. 2 gives a section through one of the 40 indicated H.-P.

engines on a scale of 1:10.8. The engine is arranged with the high-pressure cylinder above the intermediate cylinder, and with the latter above the low-pressure. The rod *R* is of large diameter, and is hollow, and the valve for admitting and exhausting the steam from the several cylinders works up and down inside it, in the center of the engine—hence the name "central valve." A separate view of the valve is given in fig. 3. It is driven in the usual way by an eccentric, but since the valve face—the inner surface of the hollow rod—moves up and down with the pistons, the source of the valve motion—the eccentric—must move up and down with the pistons also. This is effected by mounting the eccentric on the crank-pin, instead of on the shaft as usual. The ports through which the steam enters and leaves the respective cylinders are simply holes in the hollow rod, shown at *e e*, 6 6 and 3 3. These are exposed alternately to



steam coming from above, through the rod, and to exhaust—also through the rod—downward according as the corresponding pistons of the valve, marked *f*, *d*, and *b*, pass below the holes or above them.

Steam enters at the top, through the governor throttle-valve shown in section, into the steam-chest. The top of the hollow rod, though uncovered, is closed against the steam by the uppermost piston, *g*, of the valve, which works in the part above the holes 10 10. Steam can therefore enter the rod when the holes 10 10 are in the steam-chest, as they are when the high-pressure piston is near the upper part of its travel. On commencing the down-stroke *f* is just passing below the holes *e e*, and therefore admits steam into the first or high-pressure cylinder by way of 10 10 and 9 9; *f* rises again, and closes the ports 9 9, when the piston has descended about three-quarters of its stroke; but cut-off is effected earlier than this by the holes 10 10 leaving the steam-chest and passing through the gland in the cylinder cover, thus losing their supply of steam. It is evident that cut-off may be made to take place at any part of the stroke, merely by making the holes 10 10 higher or lower in the rod; the lower they are the earlier in the stroke will they leave the steam-chest. The same effect is produced by altering the height of the gland in the cylinder cover. After cut-off the steam acts expansively on the high-pressure piston in the usual way. By the time the piston has reached the bottom of its stroke, the piston valve *f* has passed above the ports *e e*, and, as the valve *e*, fig. 3, permanently blocks the passage between 8 8 and 7 7, a way is opened from above the high-pressure piston, through *e e* and out again by 8 8, into the space below the piston, and marked "first receiver." During the up-stroke—effected by the momentum of the fly-wheel only—the steam is merely transferred, practically without change of volume or pressure, into the receiver. The "receiver" might be open to the atmosphere, so as to allow the steam to escape at once, the two lower cylinders with their pistons and valves being omitted. In that case the cycle would be already complete, and in fact the above description would be all the description needed for a Willans simple engine, such as would be used where only low-pressure steam was available. In the present case, however, the receiver—which is partly composed of the lower end of the high-pressure cylinder—forms also the steam-chest for another cylinder, which in a compound engine would be the last of a series of two, but which here is the second of three.

At the beginning of the succeeding down-stroke steam passes from the receiver, by the holes 7 7, into the hollow rod again, and out by 6 6 into the intermediate cylinder, until cut-off occurs by the descent of the holes 7 7 through the cylinder cover. On the next stroke the steam exhausts, just as described above, through 6 6 and 5 5 into the second receiver; in the next down-stroke it passes into the low-pressure cylinder, through 4 4 and 3 3; in the next up-stroke it is transferred, through 3 3 and 2 2 into the exhaust chamber, which is in communication with the atmosphere, but it is not until the third revolution after that in which the steam enters the high-pressure cylinder that it is finally expelled from the engine. It will be noticed that the full pressure in the steam-chest is constantly acting upon the valve-piston *g*. This insures that the eccentric rod shall be kept constantly pressed against the eccentric, as well as on the up as on the down-stroke. With the steam pistons the case is different. They are much heavier, and they are all in equilibrium during the up-stroke, for there is at that time communication existing between the upper and lower sides of all of them. Special means, therefore, are required for checking their momentum on the up-stroke, so as to keep the connecting-rod brasses truly in constant thrust. This object is carried out—without, however, adding any special parts to the engine—by an arrangement which is the subject of a separate patent. The guide, which takes the side-thrust of the connecting-rod—and is more usually described in ordinary engines as the crosshead—is in the form of a piston, moving in a cylinder closed at the top; this is shown in fig. 2. At the bottom of its stroke it uncovers certain holes, *l l*, which place the guide-cylinder momentarily in communication with the atmosphere. As there is no other outlet from it, the upward movement of the guide piston compresses the air contained in the guide-cylinder, until at the top of the stroke a considerable pressure is reached, sufficient to stop the line of pistons, etc., without shock, and without allowing the upper brass to leave the crank-pin. In fact, an air-cushion is substituted for the usual steam-cushion, and since the pressure at which the compression of the air commences—unlike that of exhaust steam—is always the same irrespective of whether the engine exhausts into the atmosphere or into a vacuum, the cushioning is invariable in its action, and is just as effective in a condensing as in a non-condensing engine. The compressed air gives out its power again on the succeeding down-stroke.

It will be seen that where the piston-rod passes through the various cylinder covers a gland or stuffing-box is formed by cast-iron spring rings, similar to piston-rings, but springing inward instead of outward. Such rings have been in use for many years by the builders of these engines, and have worked well.

The Bookwalter Steel Process.

The accompanying engravings illustrate the Bookwalter process for converting crude metal into malleable iron or steel. The essential advantage claimed for this process is that in it the air-blasts are brought into contact with every portion of the metal, thereby securing a uniformity of structure throughout the entire mass which has not always been secured with other processes.

The main idea is expressed in the following statement, taken from the patent specifications:

"Having ascertained that the tendency to form local currents or vortices is much greater when the air-blasts enter the metal near the surface than when they enter at a greater depth below the surface, I devised means whereby to secure a continuously-uniform action of the air upon limited uniform quantities of the metal at one time, feeding the metal gradually to the air within a fixed or limited space. By this means small portions of the metal as they are fed to the air are driven thereby out of the zone of violent agitation of the air and metal, and thereafter are thrown back toward the greater body of metal while a new portion of the latter is being brought under the influence of the air, that portion of the metal which is submitted to the action of the air being the purest portion of the body—that is, having combined with it less scoria than any other portion—and the greater body of the metal which is not under the direct influence of the air being comparatively stationary and free from currents or vortices."

The means devised for securing the desired results consist in dividing the converter into chambers of unequal size. The

smaller one is the converting chamber, and the metal is fed into this at a uniform rate, meeting the air-blast, which forces it outward through the converting chamber and into the larger division above and upon the surface of the large body of molten metal. In this way a circulation of metal is produced until the whole of it has been submitted to the action of the air-blast and converted.

The apparatus may be constructed in different ways, some of which are shown in the engravings. In all these the general outline and form of the converter is that of a vessel supported on trunnions, and very similar in outward shape to the Bessemer converter. In fig. 1 the lower part of the converter is divided into two chambers, by means of a partition 1, of refractory material, and adjustable by a rod 2 extending through the top of the converter and provided with a rack 3 and pinion 14, by which the partition can be raised or lowered, leaving between it and the bottom of the converter a channel 4, through which the molten metal from the chamber x may flow into y, the rate of the flow being regulated as required. In fig. 2 a different form is shown, in which the opening between the two chambers is through the channel 4, the size of which may be increased or decreased by the valve 7, which is moved by the rod 2 and the screw 8. In figs. 3 and 4 the converter is shown divided by means of partition 1 in such a way that the contents of the conversion chamber are thrown diagonally across the converter; this partition may consist of tubes arranged side by side or a diaphragm provided with a series of tuyeres. Fig. 5 shows another construction in which the division is made by a transverse partition projecting above the surface of the metal, and inclined at one side, across which the air-blast at any suitable angle is directed to meet the stream of metal flowing through the channel 4 under the partition.

It will be seen that all these arrangements present substantially the same principle—that is, the two chambers and the circulation of the metal under the air-blast.

This process is covered by patent No. 405,766, dated June 25, 1889; issued to J. W. Bookwalter, of Springfield, O.

A New Typewriter Attachment.

A RUBBER mat, which it is claimed will deaden the noise of a typewriter, produce an easier and more agreeable touch, and save the wear on the machine, is being introduced by the United Rubber Company, Trenton, N. J. This mat is of rectangular form, and is interposed between the machine and the table, forming a cushion, which reduces the noise to the lowest minimum point and furnishes an elastic bed for the machine. The idea is a good one, and the mat itself is of very neat form, and can be applied to any table or typewriter. One of these mats is in use in this office with good results.

Manufacturing Notes.

RIEHLE BROTHERS, of Philadelphia, have recently sold a 60-ton track scale to the Thomas Iron Company, Hokendauqua, Pa. Sales of testing machines include a 20,000-lbs. machine to the Penn Salt Company, Natrona, Pa.; a 5,000-lbs. transverse machine, with indicator, to the Chattanooga Agricultural Works; a 1,000-lbs. cement-testing machine for the State University of Iowa, and a number of smaller machines. This firm recently shipped a weighmaster's frame and standard, made of Turkish standard, to Algeria.

THE Port Henry Iron Ore Company is building a large new trestle for discharging ore, at the terminus of the Lake Champlain & Moriah Railroad, at Port Henry, N. Y. The trestle has a new patent chute and scale houses, fitted with the latest pattern of Fairbanks scales.

THE Pond Engineering Company, St. Louis, report a large number of inquiries for Water Works. They have lately sold to the Belleville water-works an aerator which will purify the entire supply of that city. They are also furnishing a Gaskell non-compound pumping-engine of 750,000 gallons capacity for the city of Taylorville, Ill. Their Omaha office has just closed a contract with the city of Fremont, Neb., for a complete reconstruction of the water-works, with the Holly system, including a Gaskell compound-condensing pumping-engine of 1,500,000 gallons capacity, with boilers and laying of all water-mains, hydrants, valves, etc., throughout the city. They will also furnish a complete system of driven wells, 75 ft. deep, to give a water-supply of 2,000,000 gallons daily. These wells will be put in by the Cook Well Company of St. Louis. The Company will also furnish the Greensburg Water Company, Greensburg, Ind., with two 75 H.P. boilers, with all fittings complete.

THE Chicago Splice-Bar Mill, Morris Sellers & Co., proprietors, have started up with the new 600 H.P. steam-engine and heavier train of rolls. The introduction and use of heavier sections of steel rails by many of our principal railroads has necessitated the making of much larger splice-bars than were formerly used. This they have provided for in their new machinery, and are prepared to roll bars for rails running from 70 to 100 lbs. per yard.

THE Westinghouse Machine Company, in May, sold 82 engines, footing up over 4,500 H. P.; about 2,200 H. P. being compound engines. A large number of engines have been sold recently for electric lighting purposes, including one of 200 H. P. to Elgin, Ill.; two of 65 H. P. to Springfield, Mass.; one of 125 and one of 60 H. P. to Council Bluffs, Ia., and a smaller engine to Hayward, Cal. The Company has supplied two compound engines of 200 H. P. for the electric railroad between Omaha and Council Bluffs. The Baldwin Locomotive Works, in Philadelphia, have recently ordered a 200 H. P., compound engine.

AT the Pennsylvania Steel Company's Works, Steelton, Pa., a Bessemer steel shaft was recently cast successfully, which weighed 45,000 lbs. The mold was 25 ft. long and 29 in. in diameter.

THE Fitchburg Steam Engine Company, Fitchburg, Mass., is furnishing the power plant for the North Adams Electric Railroad, including one single engine and one tandem compound engine.

THE contract for two large duplex gas compressors and boilers, for the Kentucky Rock Gas Company, has been placed with the Clayton Air Compressor Works, New York. These compressors have a capacity of 2,000,000 cubic feet per day, and are to compress the natural gas at the wells to a pressure of 200 lbs. per square inch, and force it a distance of 32 miles to Louisville, for light and power purposes.

Bridges.

THE Berlin Iron Bridge Company, East Berlin, Conn., has just completed 23 spans of iron bridge for the Hartford & Connecticut Western Railroad; these spans are of different lengths and replace old wooden bridges. The Company is erecting an iron bridge, with three spans of 150 ft. each, for the Somerset Railroad, at Carratunk Falls, Me. The Company also has on hand an iron bridge across the Canadian River in Texas; and iron buildings for the Wilcox & Crittenden Company, at Middletown, Conn.; for the Holmes, Booth & Hayden Company at Waterbury, Conn., and for the Shelby Iron Works at Shelby, Ala.

THE Louisville Bridge & Iron Company has a contract for several new spans of iron bridge for the Louisville & Nashville Railroad.

THE Pittsburgh Bridge Company has a contract for a new highway bridge over the Conemaugh River, to have two spans of 160 ft. each.

THE Atlanta Bridge Company, Atlanta, Ga., has the contract for an iron bridge over the Tallapoosa on the Anniston & Montgomery Railroad. This bridge will have a draw span 250 ft. long; two fixed spans of 150 ft. each; one of 100 ft., and one of 75 ft.

THE Milwaukee Bridge & Iron Works has taken the contract for the new bridge over the Illinois River, at Beardstown, Ill. The bridge will have a draw span 300 ft. long and seven fixed spans of 107 ft. each.

Cars.

THE Pennsylvania Company's car shops at Fort Wayne, Ind., are building 100 refrigerator cars for the Pittsburgh, Cincinnati & St. Louis road; 30 having been completed. These cars are of the pattern of which 50 were built some time ago for the Union Line. The form of the car is the same as that of the Pennsylvania export refrigerator car, but there is a difference in the ice compartments. Instead of the closed tanks of galvanized iron, used in the export cars, the ice compartments consist of two iron baskets in each end of the car, lined with galvanized wire netting, and separated from the body of the car by partitions or bulkheads, with an open space above and below, giving a free circulation of air over the ice. These cars are equipped with the Graham draft-rigging, air-brakes, and Janney couplers.

THE Missouri Car & Foundry Company, St. Louis, Mo., is building 300 fruit cars for the Louisville & Nashville Railroad.

THE Ohio Falls Car Works, Jeffersonville, Ind., has a contract for 200 fruit cars for the Louisville & Nashville Railroad.

THE Industrial Works at Bay City, Mich., have completed a large iron transfer crane of 15 tons capacity for the Chicago, Rock Island & Pacific Railroad, and are building for the same road several boiler cranes for station use.

Marine Engineering.

THE new side-wheel steamer *Kennebec* has recently been put in service between Boston and ports on the Kennebec River. This vessel was built at Bath, Me.; is 265 ft. long; 37 ft. beam; 62 ft. over the guards, and 13 ft. depth of hold. She is handsomely fitted up with abundant accommodation for passengers. The engine was built by the Morgan Iron Works, New York; it is a beam engine, with cylinder 60 in. in diameter and 11 ft. stroke; the wheels are 33 ft. diameter and 8 ft. face.

THE Harlan & Hollingsworth Company, Wilmington, Del., is building for the New York, New Haven & Hartford Company a transfer boat to take the place of the old *Maryland*, between Jersey City and Harlem. The boat is 250 ft. over all, and 66 ft. width of deck; she will have two independent, horizontal compound engines, with cylinders 24 in. and 44 in. in diameter and 9 ft. stroke, placed one on each guard and furnished with steam by four steel boilers in the hold.

THE Continental Iron Works, Brooklyn, N. Y., have just shipped to Hammond & Coon's Lake Erie Boiler Works, Buffalo, N. Y., 16 of their corrugated boiler furnaces, to be used in the boilers of the new *Old Colony* steamer, for which this firm holds the contract.

THE Harlan & Hollingsworth Company have recently completed a new steel passenger steamboat for the New Jersey Central Railroad, to run between New York and Sandy Hook, in company with the *Monmouth*, built last year. The *Sandy Hook* is 230 ft. long; 37 ft. beam; 49 ft. wide, over the guards; 15 ft. 6 in. depth of hold, and draws about 10½ ft. of water. The boat is propelled by twin screws, each driven by an independent triple-expansion engine, with cylinders 22, 36, and 55 in. diameter and 28 in. stroke. Steam is furnished by four Scotch boilers, made to carry a working pressure of 160 lbs. The passenger accommodations are very handsome, and the boat is provided with electric lights and all the latest improvements.

OBITUARY.

DANA C. BARBER died July 1, at Knowles, Md. Mr. Barber was a most careful and painstaking engineer, and was associated with Rudolph Hering in the very extensive surveys made by that gentleman for an improved water-supply for the city of Philadelphia. His last work was the preparation of an Index of articles pertaining to sewerage and sewage disposal. He was for some time connected with the *Engineering and Building Record.*

CHIEF-ENGINEER WILLIAM H. HUNT, U.S.N., retired, died at his residence in Washington, D. C., Tuesday, June 25, 1889. After a thorough course of scientific preparation he entered the Navy as third assistant-engineer. He was a gallant and accomplished officer, his service extending through the entire period of the War of the Rebellion, serving with great credit and efficiency in the fleet of Admiral Farragut. Many personal deeds of daring and bravery in his chosen profession attest the value of his services to the Government. Mr. Hunt leaves a widow and three sons.

JAMES BEGGS, a well-known mechanical engineer, shot and killed himself in Trenton, N. J., July 19, while on a visit to that city. He was 50 years old, was born in Paterson, N. J., and was a resident of that city. He had been Master Mechanic of the Delaware, Lackawanna & Western shops in Scranton, Pa., and Superintendent of Crane Brothers' works in Chicago. For some years past he has been head of the firm of James Beggs & Company, manufacturers of machinery and supplies, having offices in New York and works at Erie, Pa. No cause for Mr. Beggs's suicide is known, and it is believed that he was temporarily insane.

PERSONALS.

M. M. MARTIN is Superintendent of Car Department of the Wabash Western Railroad, with office at Decatur, Ill.

WALTER ANCKER has been appointed Acting Supervisor of Steamboats of the Baltimore & Ohio Railroad.

GEORGE A. QUINLAN is now Chief Engineer and General Superintendent of the Houston & Texas Central Railroad.

HORACE A. TAYLOR, of Wisconsin, has been appointed Commissioner of Railroads in the Interior Department at Washington.

C. C. WAITE has resigned his position as Vice-President and General Manager of the Cincinnati, Hamilton & Dayton Railroad.

E. T. TURNER, C.E., has been appointed Director of the New York State Meteorological Bureau and Weather Station at Ithaca.

REID T. STEWART has been appointed Adjunct Professor of Mathematics and Engineering in the Western University of Pennsylvania.

J. B. BARNES is now Superintendent of Motive Power and Machinery of the Wabash Western Railroad, with office at Springfield, Ill.

HENRY C. MEYER, Editor of the *Engineering and Building Record*, sailed from New York for Europe, July 6, for a month's vacation.

GEORGE W. PRESCOTT is Superintendent of Machinery and Car Department of the California Southern and California Central Railroads.

THOMAS RODD, formerly Principal Assistant Engineer of the Pennsylvania lines west of Pittsburgh, has been appointed Chief Engineer, to succeed Mr. F. Slataper.

F. M. THORN has resigned his position as Superintendent of the United States Coast Survey, after a term in which he has filled the office very successfully.

H. R. WHEELER is now Engineer in Charge of the Zigzag Tunnel improvement on the New York, Ontario & Western Road, and has his headquarters at Walton, N. Y.

W. S. MORRIS, recently on the Wabash, has been appointed Superintendent of Motive Power of the Detroit, Lansing & Northern and Chicago & West Michigan Railroads.

COLONEL H. T. DOUGLAS has been appointed Chief Engineer of the Baltimore & Ohio Railroad. He has been for some time Chief Engineer of the Philadelphia Line.

WILLIAM WILSON, for a number of years past Superintendent of Machinery of the Chicago & Alton Railroad, has resigned that position on account of his health.

GEORGE S. MORISON, C.E., has removed his Chicago office from 205 La Salle Street to The Rookery, Room 1120. His New York office remains at 35 Wall Street, as heretofore.

F. W. D. HOLBROOK, late Principal Assistant Engineer, has been appointed Manager of the Seattle, Lake Shore & Eastern Railroad, with office at Seattle, Washington.

J. HERBERT SHEDD, of Providence, R. I., is Consulting Engineer, and WILLIAM M. BROWN is Chief and Resident Engineer of the new water-works at Wellington, Kan.

P. LEEDS has been appointed Superintendent of Machinery of the Louisville & Nashville Railroad. He was recently Master Mechanic in charge of the Louisville shops of that road.

ANDREW ONDERDONK, recently on the Baltimore & Ohio, is now Chief Engineer of the Roanoke & Southern Railroad, with office at Winston, N. C.

GEORGE HACKNEY has resigned his position as Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad, after a long term of service on the road.

COLONEL WILLIAM E. MERRILL, U. S. Engineers, has gone to Paris as the American representative to the Congress of Waterway Engineers to be held in connection with the Exposition.

A. W. QUACKENBUSH has been appointed Superintendent of Machinery of the Chicago & Alton Railroad, with office at Bloomington, Ill. He was recently General Master Mechanic of the Wabash Western.

F. SLATAPER, who has been in the service of the Pennsylvania Company continuously for over 25 years as Chief Engineer, has been appointed Consulting Engineer, having decided to retire from active work.

GAVIN CAMPBELL has been appointed General Superintendent of the Wisconsin Central Railroad. He was formerly Master Mechanic of that road, but for several years past has been General Manager of the Green Bay, Winona & St. Paul.

COLONEL JOHN G. PARKE, U. S. Engineers, has been placed on the retired list of the Army at his own request, after 40 years of service. For some time past he has been at the head of the Military Academy at West Point.

HARVEY MIDDLETON has been appointed Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad in place of George Hackney, resigned. Mr. Middleton has been for some time Superintendent of Machinery of the Louisvi le & Nashville Railroad.

COLONEL JOHN N. WILSON, U. S. Engineers, has been relieved from duty in charge of the Washington Aqueduct extension. He retains charge of the Washington Monument, and is still Commissioner of Public Buildings and Grounds. He is succeeded in charge of the Washington Aqueduct by LIEUTENANT-COLONEL GEORGE H. ELLIOT.

DR. THOMAS C. MENDENHALL, of Indiana, has been appointed Superintendent of the United States Coast and Geodetic Survey. He is now President of the Rose Polytechnic Institute at Terre Haute, Ind., and has served as Professor in the Ohio University and in the Imperial University of Japan ; he was also for some time connected with the United States Signal Service.

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The Twenty-third Annual Convention began at Saratoga Springs, N. Y., June 25. The presidential address was delivered by Mr. McWood, and short speeches were made by the Chairman of the New York Railroad Commission and by Mr. Coffin, of Iowa.

The Secretary's report showed a total of 140 Active ; 93 Representative, and 5 Associate members. The number of cars represented is about 800,000. A balance of $190 cash is on hand.

After the appointment of the usual committees an adjournment was had until afternoon.

At the afternoon session the Committee on the Interchange of Passenger Cars reported that there was no immediate demand for a code of rules for passenger cars and recommended that the matter be dropped. This was followed by a long discussion and finally the report was approved, but it was resolved to include the question of Standard Height of Draw-bars for Passenger Cars in the subjects for discussion.

The reports of the Committees on the Standard Journal-Box Lid and on Journal Lubrication were read and discussed.

On the second day the Nominating Committee presented its report ; the rest of the session was devoted to the discussion of the Rules of Interchange, according to the provisions of the Constitution. No other business was done on that day except to listen to an address from Mr. Coffin, and to a report from the Committee to amend the by-laws in relation to the place of meeting.

On the third day the Rules of Interchange, as amended at the previous session, were approved and adopted as a whole.

The report of the Committee on Car Heating and Ventilation was read and discussed. It was a very elaborate one, giving statements of the experience had with all the different systems of heating which have been actually in use.

The Committee on Specifications for Cast-Iron Wheels submitted a form of contract to be made with wheel-makers, giving also the reasons for the form adopted. The mileage basis for settlement by the Committee is as follows :

36-in. passenger wheels	70,000 miles.
33-in. passenger wheels	60,000 "
36-in. engine and tender wheels	60,000 "
33-in. engine and tender wheels	50,000 "
30-in. engine and tender wheels	45,000 "
28 and 26-in. engine and tender wheels	40,000 "
Refrigerator, through line and cattle cars	24 months.
All other freight cars	48 "

The report was received and the amended contract ordered submitted to letter ballot.

The report of the Committee on Standard Axles for 60,000 lbs. Cars was read, and its recommendation was also ordered to be submitted to letter ballot.

The Committee on Standard Brake Gear for Air-Brake Cars and Brake Shoes for Iron Beams presented a long and elaborate report, which was received, and the standard recommended was ordered submitted to letter ballot. These standards were as follows :

1. That the maximum train-pipe pressure be 70 lbs.
2. That the brake power exerted on all freight cars be 70 per cent. of their light weight.
3. That the arrangement of the brake gear for the four conditions named be as shown on sheet 3.
4. That the details as shown on sheet No. 2 be adopted, with all levers 1 in. in thickness. All pins be turned to $1\frac{1}{8}$ in. in diameter, with $\frac{1}{64}$ in. loss. All jaws or clevises to be $\frac{7}{8} \times 2\frac{1}{4}$ in. iron. All rods to be $\frac{5}{8}$ in. in diameter, and all other details as recommended.
5. That the position of train-pipe cock and dummy coupling be as shown on sheet No. 1.
6. That the brake beams for all present forms of freight cars be required to stand a stress of 7,500 lbs., with a maximum deflection of $\frac{1}{16}$ in. ; and where it is necessary to use a stronger beam that they stand a stress of 15,000 lbs., with a maximum deflection of $\frac{1}{16}$ in. Where the Westinghouse beam is employed, that the plan shown on sheet No. 4 be standard.
7. That where independent brakes and rubbers are used, that the present standard Christy or Collin rubber be maintained.

The Committee on Buffers and Carrier Irons for the Master Car-Builders' type of coupler was read, and its recommendations were also ordered to be submitted to letter ballot.

The Committee on Subjects suggested the following subjects for discussion at the next Convention, in additionto those carried over, and their report was adopted :

1. A standard and axle box for both 40 and 60,000-lbs. cars and new standard lid.
2. Best metal for brake shoes.
3. Ventilation for steam-heated cars.
4. A system of joint car inspection.
5. Car seats.
6. The substitution of steel plates and malleable iron for cast iron in car construction with a view to reduction of weight.
7. Lighting passenger-train cars.

For the place of next annual meeting several cities were suggested, including Charleston, Chattanooga, and Buffalo. A ballot was taken, but afterward by vote of the Association the by-law was suspended and Charleston, S. C., was designated as the place for holding the Twenty-Fourth Annual Convention.

The following officers were elected for the ensuing year : President, William McWood ; Vice-Pesidents, Charles A. Schroyer, E. W. Grieves, J. S. Lentz ; Treasurer, John Kirby ; Executive Committee, R. C. Blackall, E. Chamberlain, F. D. Casanave.

After the adjournment of the Convention the Executive Committee re-elected Mr. J. W. Cloud, Secretary.

After passing the usual resolutions the Convention adjourned.

American Society of Civil Engineers.—The Twenty-first Annual Convention met at Seabright, N. J., June 20. Mr. J. J. R. Coes was chosen Chairman of the Convention.

On the following day three sessions were held. At the morning session, Theodore Cooper presented a paper on American Railroad Bridges, which was briefly discussed. The Secretary read a discussion by C. Palmer on the forthcoming paper on Timber Trestle Bridges for Railroads, by Onward Bates, and H. B. Seaman presented a paper on Componential Trusses for Traveling Cranes.

At the afternoon session a paper was presented on Lime Sulphite Fiber Manufacture in the United States, by O. E. Michaelis, with some remarks on the chemistry of the process, by Martin L. Griffin. The Secretary read a paper on the Sibley Bridge, by O. Chanute and W. H. Breithaupt, and J. E. Watkins presented a paper on Development of the American Rail and Track.

The evening session was taken up by the address of the President, Max J. Becker, on Engineering Progress During the Past Year.

On June 22 the morning session was occupied by discussion of George W. Raffner's paper on Fresh Water Algæ and Their Relation to the Purity of Public Water-Supply. At the afternoon session the special Committee appointed to investigate the Cause of the Failure of the Conemaugh Dam presented their report, which was a preliminary one. This was discussed at considerable length. After the discussion a short paper by Desmond FitzGerald, on the Maximum Rain-Fall in Boston, was read.

On June 24 the report of the Committee on the Relation of Railroad Wheels and Rails was received and the Committee discharged.

Resolutions providing for a Committee to recommend Uniform Methods of Testing Material and for a Committee to re-

vise the Constitution and By-laws were referred to the Board of Directors, and a resolution providing for a Committee to Obtain Information on Impurity in Water Supplies took the same course. Resolutions were passed recommending the attention of members to the section of the National Museum devoted to Engineering Progress. A telegram of thanks for the cordial reception given to members of the Society, was sent to the English Institution of Civil Engineers.

The evening was devoted to the annual banquet of the Association.

On June 25, at the morning session, Mr. J. B. Francis discussed the effect of a Rapidly Increasing Stream of Water on the Flow below the Point of Supply, with special reference to the Johnstown disaster. A paper on Wheels and Rails, by Mr. D. J. Whittemore, and one on the Effect of Punching on Angle-Plates, by Percival Roberts, Jr., were read.

At the afternoon session a number of papers were read, and two of them on Highway Improvements, by O. H. Landreth, and on Metal Ties, by E. E. R. Tratman, were discussed.

At the afternoon session a paper on the Railroads of Mexico, by W. B. Parsons, Jr., and one on Ship Canals, by R. E. Peary, were read. The usual votes of thanks, etc., were passed, and the Convention adjourned.

A REGULAR meeting was held in New York, July 3. The Tellers announced the following elections:

Members: Waldo Emerson Buck, Lake Village, N H.; William Howard Courtenay, Montgomery, Ala.; Rob Benjamin Davis, Pencoyd, Pa.; Louis Hyde Evans, Chicago, Ill.; Joachim Godtske Giaver, Pittsburgh, Pa.; Edward Gillette, Jr., Plattsmouth, Neb.; William Rufus Northway, Chicago, Ill.; Samuel Harrison Smith, San Francisco, Cal.; Benjamin Thompson, Chattanooga, Tenn.; Paul Sourin King, New York.

Associates: Julius I. Livingston, Bound Brook, N. J.; Thomas Spencer Miller, New York.

Juniors: Norman Smith Latham, Brooklyn, N. Y.; Ludwig Paul Wolfel, Pencoyd, Pa.

Roadmasters' Association of America.—The seventh annual meeting will be held in Denver, Col., September 10, and will continue for three days.

The Committee appointed to prepare a programme of questions for discussion at this meeting have submitted the following:

1. Standard Track-Joints—R. Caffrey, Chairman.
2. Standard Frogs—P. Nolan, Chairman.
3. Labor on Track—O. F. Jordan, Chairman.
4. Automatic Switch-Stands and Protection of Facing Points—Robert Black, Chairman.
5. Track Tools and Implements—S. L. Swinney, Chairman.
6. Standard Cattle-Guards—J. Doyle, Chairman.

Denver Society of Civil Engineers.—At the regular meeting, June 11, A. J. Fonda was elected Second Vice-President and W. W. Follett, Treasurer.

The greater part of the evening was devoted to a discussion of the paving question—a live subject in Denver at present. It was the opinion of the members present that the hardest Colorado sandstone was the proper material with which to pave streets with heavy traffic, but that the streets of lighter travel ought to be paved with Trinidad asphalt.

AT the regular meeting, July 9, Thomas Withers was elected a member. A committee was appointed to prepare and arrange a collection of specimens of sandstone, presented by the Capitol Commission.

Mr. Edmund T. Martin described the Fourteenth Street Viaduct in Denver, which will extend along the south bank of Cherry Creek and across the Platte River to North Denver, having a total length of 3,500 ft. It will cross most of the railroads entering the city, and will have a roadway 40 ft. wide, and two 8-ft. sidewalks. It will be built of iron and earth embankment, and will cost when complete $107,000. The earth embankment along the bank of Cherry Creek will be supported by a wall of slag 8 ft. in height.

The subject of dams being under discussion, Mr. E. S. Nettleton gave a description of the proposed dam across the Rio Grande at El Paso, which is to be built jointly by the United States and Mexico. There are three proposed sites for this dam. It will be 60 ft. high and from 450 to 700 ft. long, according to the site chosen. The reservoir or lake formed will be 3½ miles wide and 15 miles in length. The water will be stored up to be used for manufacturing and irrigating purposes, and the flow controlled by gates.

Car Accountants' Association.—The Fourteenth Annual Convention was held at Mackinac Island, Mich., June 25 and 26, seventy-three roads being represented. After the address of President A. P. Wilder the first order of business was the election of officers, which resulted as follows: President, E. C. Spalding, Western & Atlantic; Vice-President, E. M. Horton, Illinois Central; Treasurer, H. G. Sleight, Terre Haute & Indianapolis; Secretary, H. H. Lyon (re-elected).

The reports of the committees on the following subjects were then submitted: Distribution of Cars; Carding Foreign Cars; Cypher Code; Per Diem Charges; Demurrage; Junction Card Reports; Diversion of Freight Cars.

The report of the Committee on Per Diem Charges indorsed the mixed system on the basis of ½ cent per mile and 10 cents per day. In a lengthy discussion which ensued it was shown that a large number of the roads represented at the meeting favored the straight per diem system, and it was decided by vote to lay the report of the Committee on the table until the next annual meeting, pending the action of the General Time Convention on the question.

There were also interesting discussions of the questions of Demurrage and Diversion of Cars. The following resolution was adopted:

"That it is the sense of this Convention that we have a standard penalty for diversion of cars, and that we make that recommendation to the General Time Convention and leave the matter of penalty to that convention."

It was decided to hold the next annual meeting in New York in May or June, 1890, the exact date to be fixed by the Committee of Arrangements.

Civil Engineers' Club of Cleveland.—At the regular meeting, July 9, the subject for the evening was Architecture. F. S. Barnum opened the discussion with a paper on Domestic Architecture—A Comparative View, contrasting the elegance and convenience of 40 years ago with that of the present day. Ludwig Herman told of a famous bath near Prague, called "Queen Lebusa's bath," which is all that remains of a palace that stood there in the third century. The club voted to have a picnic on August 13, the date of the next regular monthly meeting, when the subject will be Railroad Engineering.

NOTES AND NEWS.

Fast Trains.—On the Atlantic City Division of the Philadelphia & Reading Railroad a run from Camden to Atlantic City, 59 miles, was recently made in 59 minutes and 40 seconds. The train consisted of seven heavily loaded passenger cars and was drawn by one of 10 new engines recently built for this special service.

On the Pittsburgh, Fort Wayne & Chicago Railroad on May 19 last, the Limited Express made the run from Fort Wayne to Chicago Station, 148.3 miles, in 2 hours and 59 minutes, or an average speed of 49.7 miles an hour. The delays from reduced speed and stops amounted to 21 minutes, making the actual running time 158 minutes and the average speed 56.3 miles per hour. The fastest long-distance run was 57.1 miles in 60 minutes; the fastest medium run was 29.2 miles in 27 minutes; the fastest short run 6.3 miles in 5 minutes 20 seconds, or at the rate of 71 miles per hour. In this run the maximum ascending grades encountered were one of 26 ft. to the mile, 4.2 miles long; one of 24 ft. to the mile, 4.3 miles long; and one of 18 ft. to the mile, 3.2 miles long. The number of curves on the line is 23; the maximum curvature 5°, the average curvature 2°.

The train consisted of one combination, one dining and three sleeping-cars, or five cars in all, its total weight being 438,500 lbs. The train was drawn by engine No. 200, which has 18 × 24-in. cylinders, a boiler 54 in. in diameter, four 62-in. drivers and weighs in all 91,900 lbs. The tender tank has a capacity of 3,600 gals., and the longest distance run for water was 84.2 miles.

The San Diego Flume.—This important work, which has been built by the San Diego & Coronado Water Company, is intended to carry water to the city of San Diego, Cal., and also to supply water for the irrigation of several large tracts of land. The water-shed is in the Cujamaca Mountains, and the Company has constructed a reservoir at a point about 5,000 ft. above sea-level by building a dam 35 ft. and 720 ft. long. The capacity of the reservoir is about 3,740,000,000 gallons. The flume, through which the water is carried, is about 36 miles long, following generally the course of the San Diego River and the Cajon Valley to a reservoir situated on the table-land back of San Diego, at a point 630 ft. above the sea, whence water will be taken into the city in pipes. The main flume is 6 ft. wide and 4 ft. high, built of red-wood plank 2 in. thick,

and is strongly constructed and braced; where possible it rests on rock foundation, but in many places it has been carried over valleys and depressions on wooden trestles and at other points it has been necessary to build tunnels. In addition to the city reservoir several others have been made from which water is distributed for irrigating purposes, and the Company expects to furnish irrigation for about 100,000 acres of land.

Some of the longest trestles are: The Sweetwater Pass, 1,264 ft. long and 81 ft. high; Sweetwater Pass No. 2, 720 ft. long and 25 ft. high; Sycamore Creek, 720 ft. long and 35 ft. high; Connor Creek, 688 ft. long and 34 ft. high; Knob Creek, 600 ft. long and 55 ft. high; Cut-off, 640 ft. long and 48 ft. high; Los Coches, 1,664 ft. long and 70 ft. high; Sand Creek, 600 ft. long and 58 ft. high; South Fork, 420 ft. long and 86 ft. high; Quail Canyon, 560 ft. long and 68 ft. high; Monte, 438 ft. long and 60 ft. high; Chocolate, 450 ft. long and 63 ft. high; there are over 300 smaller ones.

The most important tunnels are: Lankersheim, 1,900 ft. in length; Los Coches, 313 ft.; El Monte, 290 ft.; Cape Horn, 700 ft.; South Fork, 200 ft.; Anderton, 270 ft.; and Sand Creek, 430 ft. These are through solid rock of granite or slate, 6 ft. square, cemented and arched overhead, supports being placed wherever the rock is soft or has any indications of falling.

This is the most important work of the kind on the Pacific coast. It has just been completed, and will soon be in full use.

Shipbuilding in Japan.—On March 12 there was launched at the Imperial dockyard at Yokosuka a new despatch boat named the *Yayeyama Kan*, which is 312 ft. long, 34 ft. wide, has a main draft of 15 ft. and a displacement of 1,600 tons. The ship is intended for speed, and is expected to run up to 20 knots an hour. She will be armed with three 12-cm. guns and some smaller machine-guns and two torpedo tubes. The ship is of steel throughout and has been built, with the boilers, entirely in Japan, but the engines are of English construction, being furnished by Leslie & Company, of Newcastle. They are triple-expansion engines, with cylinders of 31 in., 46 in., and 68-in. diameter and 28-in. stroke, each working a separate screw. The working pressure carried will be 150 lbs., and steam will be furnished by six boilers.

Compound Locomotives in England.—The Northeastern Railway Company is now building at its Gateshead Shops, five compound passenger locomotives of exceptional power and size. These engines are on the Worsdell & Von Borries system, of which the Company already has a number in use. The new engines have a forward truck, one pair of drivers 7 ft. 6 in. in diameter and one pair of trailing wheels. The high-pressure cylinder is 20 in., and the low-pressure 28 in. in diameter, both being 24-in. stroke. They are intended to run the Company's fast express trains.

Baltimore & Ohio Relief Department.—The balance sheet for May shows the payment of benefits by the Relief Department of the Baltimore & Ohio Railroad as follows:

	Number.	Amount.
Accidental death	4	$4,500
Accidental injuries	247	3,551
Natural deaths	18	6,151
Natural sickness	290	4,452
Surgical expenses	151	879
Total	710	$19,533

The Relief Department of the Baltimore & Ohio Railroad is the successor, under the new arrangement, to the old Baltimore & Ohio Employés' Relief Association.

Nails from Tin Scrap.—In a recent paper before the Institute of Mining Engineers, Mr. Oberlin Smith describes a method of making nails from tin scrap, now usually considered as waste. After describing some preliminary experiments, he says: "Our second machine, instead of working upon the principle of regular corrugations, simply crushed up the blanks edgewise into any form they chose to assume.

"The machine now under construction has been very much simplified, and made enormously strong and heavy. It is adapted to cutting, crushing, griping, and heading the nails at one operation, and can be run as fast as an expert operator can feed the material. Its feed probably varies, with jagged, irregular scrap, from 30 to 90 nails per minute, although straight strips of sheet-metal can easily be fed by hand into a machine running as high as 240 strokes per minute.

"During the course of our experiments, various forms of nails have been tried. Among others were straight cylindrical nails with conical points; straight, square nails with pyramidal and with wedge-shaped points; hexagonal nails, etc. The most practical form, however, seems to be a square taper nail, which has about the same shape as the ordinary cut nail, but is somewhat stronger and a good deal tougher. It is well adapted for all ordinary purposes, but is especially suitable for a roofing nail, since the tin coating prevents much rusting, and is good to solder to.

"Among other processes, we have tried winding the nail blank upon itself, after the manner of a window-shade, but minus a mandrel. This, however, was difficult in execution, and was not found available in practice.

"The economy of this system of nail-making is obvious. The scrap can be bought for about 17 cents per 100 lbs., and a boy can make perhaps 100 lbs. of nails per day."

Railroads in Algeria.—In the year 1879 the general plans for the construction of the railroads of Algeria were drawn up, and these plans having been rigidly adhered to, the various lines are rapidly approaching completion. The plans referred to are based upon, first, the commercial interests of the country; second, the defense of the territory against enemies, either foreign or domestic.

The total length of completed railroads in Algeria is 1,683 miles, and can be divided into two great sections.

1. That section which includes the lines running parallel to the seashore, and extending from the frontier of Morocco to the boundary of Tunis, and connecting all the seaports of Algeria.

2. This section includes all the lines running from the sea-coast to the interior, which may be more properly termed "lines of penetration." In the case of insurrection these lines would be of very great importance and utility in moving troops with despatch. From a commercial point of view, the whole of these lines are of vital importance, and will assuredly contribute much to the rapid development of the colony. Prior to the building of these lines the means of transportation were of the most primitive description, whereas now the facilities afforded and low rates granted permit of the products of the interior being carried to the seaboard, where ready markets are always to be found.

The railroads are under the control of six companies: The Paris, Lyons & Mediterranean Company; the East Algerian Company; the Bone-Guelma Company; the West Algerian Company; the Franco-Algerian Company, and the Moktabel-Hadid Company.

Two new lines are under construction, from Oued-Rhamour to Ain-Beida and from Blidah to Berroughia, and other lines of less importance are being surveyed. One of these is to extend to the Tunisian frontier, and another to the iron mines of Rio Salado.

Variations in Thickness of Large-Rolled Plates.—Constructors in different countries now demand from the forges and rolling-mills plates of iron and steel of very large size, and the rolling of these plates of even thickness presents considerable difficulties. It has been thought important to make some tests of this matter, and three German manufacturers—Krupp at Essen, Schultz-Knaudt at the same place, and Grillo, Funke & Company at Schalke—have made recently a series of experiments. This was done by taking a large number of micrometric measurements of large plates in such a way as to determine their maximum and minimum thickness, and then comparing these with the average thickness, which was obtained by calculation from the weight of the plates, assuming a density of 7.76.

The results obtained from three specimen plates in this way were as follows, reduced to inches:

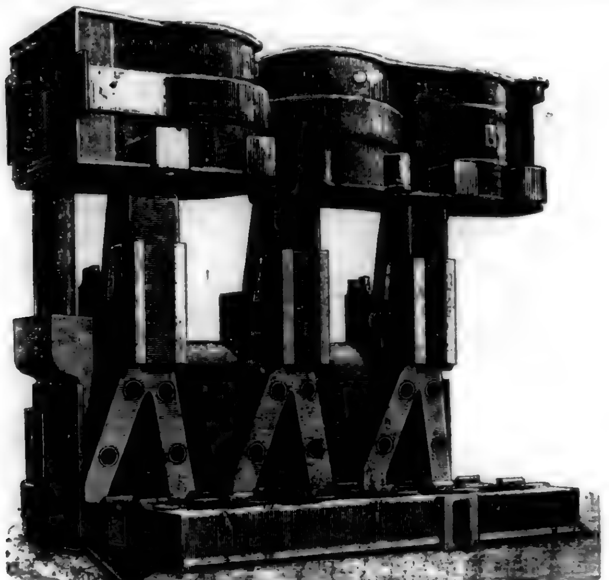
Maker.	Size of Plate.	Thickness of Plate.		
		Minimum.	Maximum.	Calculated.
1. Schultz-Knaudt	118 × 151 in.	0.4772 in.	0.5728 in.	0.5575 in.
2. Grillo, Funke & Co.	86 × 100 "	0.7146 "	0.7563 "	0.7394 "
3. Krupp	110 × 141 "	0.5118 "	0.6220 "	0.5972 "

In No. 1, the largest and thinnest plate, the total variation was 0.0956 in., the minimum measurement being 14.2 per cent. below, and the maximum 2.7 per cent. above the calculated thickness. In No. 2, the heaviest plate, the total variation was 0.0417 in., with the minimum 3.4 per cent. below, and the maximum 2.3 per cent. above the calculated thickness; this plate showed the least variation. No. 3 showed the greatest variation, the total difference being 0.1102 in., the maximum being 4.2 per cent. above, and the minimum 14.3 per cent. below the calculated thickness.

It will be readily understood that if such irregularities are found in specimen plates they may be still greater in those made in ordinary work, without special care, and the resulting in-

conveniences can at once be seen. There is, therefore, a serious reason for not exceeding the dimensions already reached for rolled plates, especially in making boilers, at least until new improvements are made in rolling.—*Le Genie Civil.*

A Remarkable Casting.—The accompanying illustration, from the London *Engineer*, shows a remarkable casting, which is exhibited in the Paris Exposition by the John Cockerill Company, of Seraing, Belgium. This casting is shown in its untrim-



med condition and weighs about 24,000 lbs.; it consists of the frame, cylinders, crosshead-guides, shaft-blocks, condenser, air and feed pumps of a triple-expansion engine, all contained in a single casting. It is probably more intricate in detail than any one casting ever made, and is certainly a very remarkable piece of work. It is not meant to serve any purpose, and is not likely to be repeated; the intention being merely to show what can be accomplished by the pattern-maker and molder. This casting was designed by M. Resimond, head of the foundry department at Seraing, and was executed under his direction.

A London Rapid-Transit Project.—London, like New York, is agitating new schemes for rapid transit. The latest one proposed is, in some of its features, like the Arcade plan, which at one time seemed likely to be carried out in New York. It is described in a recent number of the *Railway Press.*

The idea is to excavate the full width of the street to a depth of 14 or 15 ft., and to put at the bottom of this excavation a stratum of concrete about 2 ft. thick. A strong wall is to be built at each side about on a line with the edge of the sidewalk, and upon these walls will rest steel girders, which will carry a floor of steel plates protected by asphalt, which will carry the usual street pavement. The excavation will give room for four parallel tracks, while at each side, and outside of the railroad proper, will be a gallery in which can be placed the water-pipes, gas-pipes, conduits for electric wires, etc. It is proposed to use two of the tracks for way trains making frequent stops, and the other two for express trains stopping at longer intervals, or only at the more important stations.

The motive power of the proposed line is electricity, so that there will be no trouble with smoke or steam, while the small depth of the road below the surface will make ventilation and lighting comparatively easy. The power will be provided from stations placed wherever it may be found most convenient, as it can be readily conducted to the line where it is wanted.

Divisions are to be made between the separate tunnels of the subway by panels of a new material known as ferflax, which is a tough substance formed by compressing vegetable fiber upon a foundation of steel netting. These panels will be supported by pillars placed at proper intervals and connected above with the floor girders.

Elevated railroads are not considered admissible in London, while the present underground roads, although largely used, are not favorably regarded by the public, owing to their poor ventilation, darkness, and the long flights of stairs required to reach them from the street, on account of their depth below the surface. Additional facilities are needed, however, and this plan is proposed to meet the exigencies of the case.

Torpedo-Boats in Europe.—M. Lisbonne, late Director of Construction in the French Navy, has collected statistics showing the number of torpedo-boats completed and under construction in the principal navies of Europe. He divides these vessels into four classes:

1. Sea-going torpedo-boats, from 130 ft. to 150 ft. in length, and from 70 to 160 tons displacement.
2. First-class torpedo-boats, from 108 ft. to 115 ft. in length, and from 45 to 60 tons displacement.
3. Second-class torpedo-boats, from 85 ft. to 95 ft. in length, and from 25 to 35 tons displacement.
4. Torpedo *vedettes*, or launches, from 50 ft. to 60 ft. in length, and from 10 to 13 tons displacement.

The sea-going boats may be again subdivided into those furnished only with the ordinary torpedo tubes or guns, and those provided with automobile torpedoes and apparatus for launching them.

The number of these boats for each of the navies of the leading powers is:

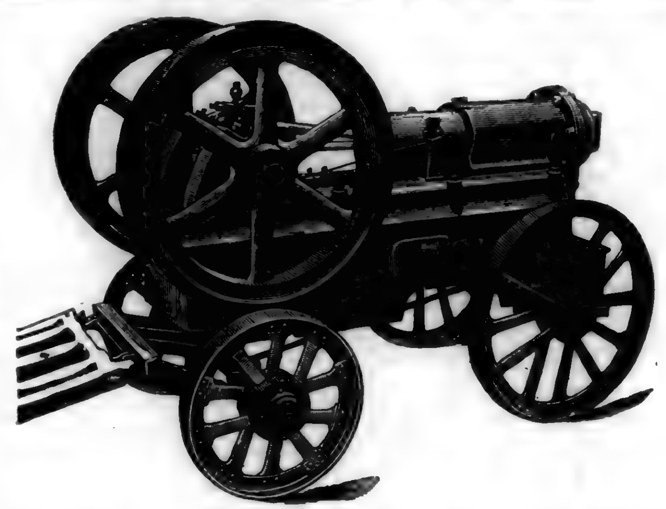
	1. Sea-going.	2. First-class.	3. Second-class.	4. Vedettes.	Total.
England	74	6	19	37	136
France	12	69	41	12	134
Italy	57	9	29	22	117
Germany	95	13	..	2	110
Austria	23	26	8	..	57
Russia	21	5	..	3	29

From this it will be seen that England and Germany have built chiefly the boats of the first and fourth classes, while Italy has also given most attention to the first class, although building also a number of the smaller ones. France, on the other hand, has built but few of those classes, having a large number of the second and third classes.

It may be noted that the torpedo-boat, built entirely for speed and loaded with all the machinery that can possibly be put on a vessel of the size, has proved, as might be expected, a very troublesome kind of ship to manage. They have yet to prove their usefulness in real warfare, but wherever they have been tried in conditions approaching those of actual service accidents and breakdowns have been numerous, and a practice cruise has generally ended in a large number of cases for the navy yards and repair shops.

Portable Petroleum Engine.—The accompanying illustration, from the London *Engineer*, shows a portable engine using petroleum, which is manufactured by Priestman Brothers, of Hull, England. The engine shown in the cut is of 6-H.P., and needs only the attachment of a horse to make it ready for transportation in any direction.

The engine itself consists of the cylinder, piston, rod, crankshaft, etc., all fitted upon a massive cast-iron bed-plate of box



form, which has fitted also inside the oil tank, vaporizer, all pipes and connections, hand pump, and heating lamp for starting, etc.; this is all secured to a wrought-iron framing, which in its turn is mounted upon substantial carriages, axles, and wheels. The water for cooling the cylinder is taken from a tub placed upon the ground, and is circulated by means of a small water pump fitted inside the bed-plate. The battery, etc., for giving the electric spark for firing the charge in the cylinder, is carried at the end of the engine in a strong wooden box secured to the bed-plate. The engine is fitted with two fly-wheels, and the fore-carriage is arranged in the usual way, with shafts for a horse. The whole machine is compact, and the total weight is much less than an ordinary portable steam-engine of equal power.

The engine is on the same principle as the Priestman stationary engine, which was described in the JOURNAL for June, 1888, page 288. It is a gas engine, the gas being produced directly by vaporizing petroleum.

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IT is stated that the plans for the two large vessels authorized at the last session of Congress have been completed, at least in general outline. The larger, or 7,500-ton ship, will be a 17-knot cruiser, about 315 ft. long, carrying several 12-in. guns and a secondary battery. This vessel will somewhat resemble the English *Warspite* class.

The smaller, or 5,300-ton ship, will be about the same length, but lighter, and built largely for speed. She will be heavily engined, is expected to make 20 knots, and in general plan resembles the *Reina Regente*, a Spanish cruiser which has attracted much attention. Her battery will include two 10-in. and a number of rapid-fire guns.

THERE seems to be a prospect of resumption of work on the tunnel under the Hudson River between New York and Jersey City. The company, it is stated, has succeeded in raising money to go on with the work, and hopes to complete it in two years. The work was first begun in 1873, but not much was done until 1879; it was stopped in 1882, and was resumed for a short time in 1887.

The intention is to make two separate tunnels, each of which will be 5,600 ft. long under the river, without counting the shore approaches, which will be about 4,000 ft. long on each side of the river.

The work heretofore done was begun on the New Jersey side of the river, and the completed sections include 2,060 ft. on the north tunnel and 585 ft. on the south tunnel. On the New York side all that has been done is a short section of about 75 ft., on the north tunnel. The work now begun is in the north tunnel from the New Jersey side, the object being to complete that one before beginning on the other.

THE Navy Department will send out an expedition to observe the total eclipse of the sun, which will take place on December 22 next. The place selected is in the Portuguese possessions on the west coast of Africa, and the naval officers and scientific men who will compose the expedition will be taken to St. Paul de Loanda on one of the new cruisers. The necessary permission has been obtained from the Portuguese Government, and arrangements for the expedition are now being made.

THE agitation with regard to the improvement of country roads in New Jersey resulted in the passage by the last Legislature of a road law, which is, however, permissive and not mandatory in its provisions. This law permits the Board of Chosen-Freeholders—which, in New Jersey, corresponds to the Board of Supervisors or the County Court in other States—to assume control of all, or any part of, the roads in a county, and to provide for their improvement and maintenance by a county tax; thus taking away the management of those roads from the township and district authorities, who have heretofore controlled them. The county authorities are authorized to lay out new roads and to make alterations in existing ones should it be deemed expedient, and the law also directs the employment of a County Engineer, to have immediate charge of the work, and to act as adviser to the Board in locating and managing the roads.

This law is a step in the right direction, and if it is acted upon to any extent, there is little doubt that the advantages of transferring the control of the roads from the District Roadmaster or the Town Board to the larger and more comprehensive unit of the county, will be so evident that the system will be generally adopted. Not only can the roads be better laid out and better managed, but the possibility of employing a competent engineer will naturally lead to the adoption of better locations and better plans for maintenance and improvement.

As to the expense, the new law provides that one-third of the cost of building and maintaining each county road shall be assessed on the township or district through which the road passes, and the remaining two-thirds upon the county at large, a division which seems to be as nearly founded in justice as any general rule of the kind can be.

The model which led to the adoption of this law in New Jersey was probably the success of the Essex Road Board, which was established by a special law several years ago, and under which there has been constructed in the County of Essex in that State an admirable system of roads leading to Newark as a center, and giving all the principal towns and villages of a populous district a far better built and managed system of roads than had been before supposed possible.

THE Morris Canal, one of the oldest artificial waterways in the country, is probably to be abandoned as a transportation line. It has been for some years past leased by the Lehigh Valley Railroad Company, and its importance as a carrier of coal has diminished in consequence of the diversion of that traffic to the railroad lines which are now everywhere parallel to it. The canal is about 100 miles long, extending from the Delaware at Phillipsburg to the Hudson at Jersey City, and in its day was a notable engineering work.

The eastern half of the canal, which draws its supply of water from the hill country of New Jersey, is to be used as a conduit to carry water to the large cities bordering on New York. A contract has already been concluded for the supply of the city of Newark, and negotiations are pending for that of Jersey City. Both of those cities now use water from the Passaic River, which is barely sufficient in quantity, and the quality of which suffers from the pollution inevitable in a river flowing through a very thickly

inhabited region. The new source of supply will be abundant in quantity and of great purity, coming from a mountain region where there is little or nothing to cause pollution, and where there are already large natural reservoirs, while as many artificial ones as may be needed can be supplied at small expense.

THE Pennsylvania Railroad Company proposes to add to its Relief Association a system of pensions for employés incapacitated for work by old age and long service. The details of the plan are not yet announced, but it is said that they will include a contribution by the company to the funds of the Association to assist in the establishment of the new feature.

THE German railroads reported for the year 1888 a total of 4,577 breakages of tires on wheels of all descriptions, on a total length of 25,330 miles worked. Most of these breakages had no serious consequences, as only 26 derailments and 268 delays are reported as having resulted from them.

For several years past the number of tire failures has been gradually decreasing. Last year, however, they showed an increase, the average having been 87 per 1,000 kilometers of single track, against 70 in 1887. This is attributed to the unusual length and severity of the winter last year, and it is stated that out of the 4,577 breakages 3,492, or 76½ per cent. of the total, occurred in the winter months.

LAST month we published some account of the great topographical map of France, which has been completed, and of the new one on a larger scale, which has been undertaken by the Geographical Corps of the Army. In the United States a similar work is now in progress. The topographical surveys upon which the map is based have been completed in Massachusetts, Rhode Island, and New Jersey, and partially made in Pennsylvania, New York, Connecticut, Maine, and New Hampshire. It may be noted that in the three States, the survey of which has been completed, one-half of the expense in each case was borne by the State. The maps of the first three named States are partly engraved ; they are made on a scale of 1 in. to the mile, which is somewhat smaller than in the French maps, which are to be on the scale of 1:50,000. These maps will be published in sheets measuring 13 × 17½ in.—that of Massachusetts requiring about 50 sheets ; of Rhode Island, 15, and of New Jersey, 50.

The atlas of the whole country will comprise about 2,500 sheets of the dimensions already given. Those of the Eastern States will be on a scale of 1 in. to the mile ; the central and southern portions of the country, and the Pacific Slope on a scale of 1 in. to 2 miles, while the region formerly known as the Plains—that is, between the Missouri River and the Rocky Mountains—by a scale of 1 in. to 4 miles. The work is under the direction of the United States Geological Survey, and the topographical work is considered as a necessary preliminary to the completion of the geological work.

FAST ocean passages are the order of the day just now, and the performance of the new steamers is looked for with interest. The great steamship *Teutonic*, of the White Star Line—which is described in another column—made a most excellent record on her first trip westward, having made the run from Queenstown to Sandy Hook in 6 days 14 hours and 23 minutes. This is extraordinary time for a new ship, and indicates great speed hereafter, especially as the voyage was made against head-winds and fog was met for 17 hours. The daily runs of the *Teutonic* were 394, 404, 430, 431, 440, 454, and 227 knots. The average speed for the whole run—2,780 knots—was 17.53 knots per hour ; the average for the best day's run was 18.92 knots an hour.

The *Columbia*, a new steamer of the Hamburg-American Line, also made an extraordinary run for a first trip, her time from Southampton to Sandy Hook being 6 days 21½ hours. The whole distance made was 3,064 knots, and the average speed was 18.5 knots an hour.

THE latest suggestion for the increase of rapid transit facilities in New York is the addition of a second deck or upper story to the present lines, on which fast or express trains could be run. The objections to increasing the height of the lines will suggest themselves at once to any one familiar with the city, and there is also the consideration whether an entire rebuilding of the present structures would not be required ; but the idea is worth considering.

THE question of liability for the Johnstown disaster may be settled in the courts, a suit having been begun by the heirs of one of the victims to recover damages from the South Fork Fishing Club, the association which owned the dam, the failure of which caused the accident. The legal questions to be settled are many and complicated, and a long and involved law-suit may be expected.

RAILROAD STATISTICS.

FOR years past the Introduction which has accompanied the yearly volume of *Poor's Manual* has combined in tabular form the statistics of the railroads furnished to the *Manual*, and this compilation has really been the only statement of the business and condition of the railroads of the United States as a whole. The defects of this statement have before been pointed out, but with those defects—which mainly arise from the fact that the figures are voluntarily furnished and not official—the Introduction has always been valuable, and the publishers deserve much credit for the care taken in its preparation.

This year the figures of the *Manual* are supplemented by the publication of the first annual report of the Statistician of the Interstate Commerce Commission. It will be remembered that the Commission some time ago called for returns from the railroad companies, and the results of those returns are presented in Mr. Adams's report.

The Interstate Commission returns were received from companies owning or operating 139,102 miles of railroad, and the Statistician estimates that there were in addition 10,800 miles of railroad, making a total of 149,902 miles. The figures for capital, earnings, etc., given in his tables are from returns received from 136,884 miles of road.

On the other hand, *Poor's Manual* reports the total mileage of railroad in the United States at 156,082 miles, but its figures are not all based on that mileage.

The Commission reports have the advantage that they cover a uniform year (that ending June 30, 1888), and were made on a uniform plan ; but *Poor's* reports, while they do not cover a uniform year, are generally brought

up to a later date, the majority of the companies covering the calendar year 1888 with their figures.

With these facts understood, it will be interesting to make some comparison of the two sets of figures, giving the stock, debt, earnings, and expenses of the railroads of the United States:

	Commission.	*Poor's Manual.*
	136,884 miles.	154,276 miles.
Stock	$3,864,468,055	$4,438,411,342
Funded debt	3,869,216,365	4,624,035,023
Floating debt	396,103,311	306,952,589
Total	$8,129,787,731	$9,369,398 954
Per mile of road	59,392	60,731
Earnings:		(145,341 miles.)
Passengers	$277,339,150	$251,356,167
Freight	613,290,679	639,200,723
Other sources	19,991,391	60,065,118
Total	$910,621,220	$950,622,008
Working expenses	594,994,656	653,258,331
Net earnings	$315,626,564	$297,363,677
Other receipts	89,593,471	84,897,880
Total	$415,220,035	$382,261,557
Fixed charges	285,492,433	288,610 506
Surplus	$129,727,602	$93,651,051

The surplus, according to the Commission report, was 3.35 per cent. on the stock, but this was probably greater than the real return. According to the *Manual*, the dividends actually paid amounted to $78,943,041.

Some of the discrepancies in the above tables arise without doubt from differing methods of classifying earnings, etc., and from the arrangement of figures under varying heads.

According to the Commission returns the railroads derived 30.46 per cent. of their earnings from passengers, 67.35 per cent. from freight, and 2.19 per cent. from other sources. The division of working expenses was: Maintenance of way, 22.60 per cent.; maintenance of equipment, 17.09; conducting transportation, 50.26; general expenses, 9.34; miscellaneous, 0.71 per cent.

The traffic figures given by *Poor's Manual* are of interest as showing the extent of business done by the railroads:

Train mileage	688,751,371
Passengers carried	451,353,655
" " one mile	11,190,613,679
Tons freight carried	589,398,317
" " " one mile	70,423,005,988
Average passenger journey	24.78 miles.
" freight haul	119.48 "
" receipt per passenger per mile	2.246 cents.
" " per ton per mile	0.907 "

The averages given show to how great an extent the local or short traffic still exceeds the through business, and also how small the average return on all the business is. No feature of the yearly returns has been more striking than the steady reduction of the earnings per unit of traffic, and it is growing each year more evident that profits on the vast capital invested in railroad business depend upon the closest economy and the use of the best appliances for working.

From 1882 to 1888 the total freight traffic of the country increased a little over 79 per cent.; but the average freight rate in the same time decreased very nearly 27 per cent. Had not there been also a decrease in the cost of doing the work, the business of 1888 would have shown no profit whatever—in other words, the average rate per ton per mile of 1888 was little or nothing above the average cost per ton per mile of 1882.

This reduction has been the result of causes too many and complex to permit their discussion here. That unrestricted railroad building and the consequent competition are the chief ones need hardly be said. Railroads have always possessed great attraction for capital, and it has been invested in them, often, it would seem, without due consideration as to whether a profit might be expected or not.

IRON AND STEEL PRODUCTION.

THE figures collected by the American Iron & Steel Association for the half-year ending June 30 last show that the production of pig iron in the United States for that period, compared with both the first and the second half of last year, was as follows:

	Net Tons.	Gross Tons.
First half, 1889	4,107,889	3,667,767
Second half, 1888	3,886,004	3,469,646
First half, 1888	3,382,503	3,020,092

The output of pig iron this year was greater than in any previous half-year in the history of the iron trade. The increase over the first half of 1888 was 725,386 net tons, or 21½ per cent.; over the second half, 221,885 tons, or 5¾ per cent.

The stock of pig iron unsold on June 30 was, however, 502,934 gross tons, an increase of 202,790 tons in the six months, this increase being almost as great as that in production.

The same authority gives the production of Bessemer and Clapp-Griffiths steel in the United States for the half-year as below, in tons, comparisons being made with the first half of 1888:

	1889.	1888.	Increase.
Bessemer	1,382,359	1,348,218	34,141
Clapp-Griffiths	38,356	36,070	2,286
Total	1,420,715	1,384,288	36,427

Of the total production this year, Pennsylvania is credited with 930,748 tons and Illinois with 245,171 tons, the remaining 244,796 tons being made in other States.

While the total steel production thus shows an increase of over 2½ per cent., the production of steel rails decreased 55,689 tons, or 7¼ per cent., having been 719,572 tons this year against 775,261 tons for the first half of 1888.

The general deductions to be drawn from these figures can be easily made. We know that there was a considerable falling off in the demand for iron for railroad purposes, while the fact that the increase in stocks on hand was almost exactly the same in amount as the increased production, shows that the actual consumption of pig iron in the first half of the present year was very nearly the same as in the first half of 1888. The falling off in the railroad consumption must thus have been made up by the increase in the demand for other purposes, and here it must be remembered that the use of iron as a structural material is growing rapidly every year. In our more important buildings iron beams are taking the place of wood. Iron bridges are everywhere replacing wood, and new uses for metal are being found every day. In all this there is much to encourage the iron manufacturer in the future; and while the railroad interest will doubtless remain their largest single customer, yet they will be every year less and less dependent upon that interest for the condition of their business.

The same thing may be said of steel. As will be seen from the table above, the production of steel showed a fair increase this year, while the demand for steel rails, on the

other hand, fell off considerably. This may well be accounted for by the increasing use of steel for boiler plates, for bridge work and other purposes, and the steel rail output will probably year by year take a less and less proportion of the total steel production.

The production of pig iron in the South, of which we have heard so much lately, showed a considerable increase, having been 744,619 tons in the first half of 1889 against 647,006 in the first half of last year. This increase was almost entirely in Alabama, the other iron-producing States of the South—with the exception of West Virginia, whose output is only about one-tenth of the whole—showing either very slight gains or an actual decrease. The total Southern production in the first half of this year was about 18 per cent. of the entire production of the country, so that it is already becoming a considerable factor in the trade, and, perhaps, has more effect than its actual amount would indicate from the fact that, in Alabama especially, Southern iron can be more cheaply produced than it can be anywhere at the North.

What has been said above in relation to the demand for and the uses of iron is supported by the fact that the increase last year was chiefly in those kinds of pig iron which are used for general foundry and mill purposes, and not in the iron used in the manufacture of steel, or Bessemer pig as it is generally called. Some complaint has been made by makers of the very low prices of iron, but the figures above given would seem to indicate that the iron trade is in a much better condition than many have anticipated.

In this connection we obtain from the same source the figures for an interesting comparison of the iron and steel production of the world, and its increase during the past 10 years. The table below gives, from the best available sources, the output of pig iron in 1878 and 1888 in the four leading iron-producing countries of the world ; showing also the total estimated production of the world, and the percentage of that total, which each of the countries named produced :

	Production.		Percentage.	
	1888.	1878.	1888.	1878.
Great Britain....	7,898,634	6,381,051	34.05	45.20
United States..........	6,489,738	2,301,215	27 98	16.30
Germany................	4,258,471	2,147,641	18.36	15.21
France	1,688,976	1,417,072	7.28	10 04
World, total..........	23,194,475	14,117,902	....	....

The total production of steel is shown in the same way in the table below :

	Production.		Percentage.	
	1888.	1878.	1888.	1878.
Great Britain...	3,405,536	1,100,000	35.18	36.41
United States..........	2,899,440	731,976	29.95	24.23
Germany................	1,785,354	570,328	18.45	18.88
France	525,646	281,800	5.43	9.33
World,total......	9,679,979	3,021,093	....	....

These two tables show in a very striking way the great increase in the production of iron and steel in the past 10 years, and show also the changes which have taken place. Great Britain, which 10 years ago turned out very nearly half the world's supply of iron, now produces only a little over one-third, while the proportion of the United States has risen from one-sixth to two-sevenths.

In steel the changes in proportion of the different producing nations have been much less, but the increase has been greater in proportion than in iron ; while the total output of iron has risen only from 14,000,000 to 23,000,000 tons—although that is a sufficiently striking growth—yet the steel production of 1888 was considerably more than three times that of 1878. Much of this great increase is doubtless due to the invention of Bessemer steel, which has so generally taken the place of the better grades of iron in all sorts of construction.

It remains also to be added that the iron and steel industries everywhere in the world almost are showing continual gains, and that the use of both metals in construction is every year becoming more general, until they promise to replace almost entirely the inferior materials heretofore employed.

THE EXPOSITION OF 1892.

THE idea that the United States shall in 1892 commemorate the quarto-centennial of the great discovery of Columbus, by inviting the Old World to meet on the soil of the new continent with those of her children who have found a home there, and compare with them the progress which each has made, seems to have crystallized into the definite project of an universal exposition.

It is in New York that the project has become thus definite. When it was first vaguely talked of there were claims made by other centers of trade and population. Not without some show of reason some of the Western cities contended that, as the latest outcome of the new civilization, divested of all Old World traditions, they would present to all those who came to join in the celebration the clearest and most definite view of the New World under its present conditions. But they will, no doubt, gracefully yield, and tender their cordial co-operation to New York, when the whole question is more carefully considered and they review the many reasons why that particular point is the proper one.

The Government of the United States as the mouthpiece of the whole people must, of course, issue the invitations to the world, and it will be a courtesy from the whole people that its guests shall be asked and their entertainments prepared at the point most accessible to them. To all of them it is known that this point is only the gateway to the great civilization beyond, which they will be anxious to see, and most of them to study, and very few will be content to leave without seeing and studying the different parts of the country which their special business or predilections make most interesting to each.

Nor will it be forgotten that upon any community which assumes the charge of such an exposition a very grave and heavy responsibility will rest. It is not alone the glory and profit which are to be considered, for in this, as in every endeavor to earn either, we all know by hard experience that there is a vast amount of labor, of thought, and anxiety to be expended, and much of censure and criticism to be incurred, whatever may be the success attained.

The time for preparation, taking into account the work to be accomplished, is very limited, more especially when it is to be conducted by a popular movement and controlled and directed largely by men who have other and often pressing business calling for their constant attention, in this differing materially from those occasions in other countries in which the Government is the controlling and directing power.

In speaking and thinking of 1892, it seems to most of us a long time to look forward, the very change in the decade giving it a further futurity ; but when we consider how much must be accomplished in two years and a half in

order to be ready for the exposition, the time will be found all too short for the work in hand.

While the necessary financial guarantees are a preliminary step of the first importance, they are outside of the questions to be here considered, and are in competent hands, and will, no doubt, be capably dealt with, though, in coming down to a consideration of their magnitude, much of the airy discussion respecting the claims of various geographical points fails to find a hearing, as it is realized that the people will require the exposition to be a commemoration of which they may be proud and which will be worthy both of the occasion and of themselves.

Although we have before us the examples and experiences of previous exhibitions in Europe, and of our own Centennial, it is the dominant feeling that we ought not to be satisfied with a mere imitation of these, with immense ranges of buildings of more or less architectural beauty and illustrative of engineering skill in construction, but that our engineers and architects shall devise an harmonious plan superior to any which has heretofore been presented—one which in itself will illustrate, or, as it might be said, graphically describe, the advances they have made in the various departments of the arts which they control. It is only those who are practically engaged in such work who know that it is not by a flash of intuitive genius that this is accomplished, but by careful, patient, and often long study, by much thought, and by a bringing together and blending of many opinions and intelligences, divergent in their modes of thought and action, and often actually hostile to each other, at least in the first development of their plans.

That beyond the first practical question of finance, the success of the exposition as an exponent of the great Western civilization will rest largely in the hands of the engineers of the country, who have done so much to build it up to its present proportions, is certain. It is hoped that it may not fail to meet with a responsive interest among them in all parts of the country through which they are scattered—not only from individuals, but from their several associations; and that such co-operation on their part may produce in 1892, not one engineering work dominating, in the popular estimation, all others, but a harmony in the whole idea and execution which shall illustrate the grand progress of every branch of the science here, and show what has been and is its co-operative work in the advancement of the civilization of the New World whose birth it will commemorate.

NEW PUBLICATIONS.

NOTES ON THE THEORY OF CANTILEVER BRIDGES: BY CHARLES MCMILLAN, C. E., PROFESSOR OF CIVIL ENGINEERING, PRINCETON COLLEGE. Octavo, paper, pp. 20, with 2 plates.

The theory of the computation of stresses in cantilever trusses is, of course, very simple to bridge engineers of experience, but to students special explanations are necessary. About one-half of this pamphlet is devoted to deducing the positions of the live load which give the greatest stresses in the various members of the truss, and the other half to a graphic method—using the equilibrium polygon—for finding the values of these stresses. The discussion includes the case of locomotive wheel loads; these are necessarily considered because often required by specifications, although, as the weights of locomotives are constantly changing, it appears to us to be a useless refinement. Professor McMillan's investigation is clear and concise and will doubtless prove valuable to those who study this important type of bridge.

THE LITERATURE OF GEODESY: COLLECTED BY DR. O. BOERSCH FOR THE INTERNATIONAL GEODETIC ASSOCIATION. Berlin; G. Reimer, 1889. Quarto, paper, pp. vii, 228.

The vast expanse of the literature of geodetic operations cannot be well appreciated without glancing over the titles of the books and memoirs to which alone 214 pages of this work are devoted. The arrangement is by countries, and it is gratifying to note that the United States ranks high in the character and number of works produced. Germany stands at the head with 60 pages of titles, France and Great Britain each have 24 pages, the United States has 21 pages, Russia 20 pages, Italy 15 pages, and eleven other countries have on the average about five pages each. A bibliographical work of this kind must prove of great assistance to students of geodesy.

BULLETIN NO. 9, U. S. COAST AND GEODETIC SURVEY: ON THE RELATION OF THE YARD TO THE METER: BY O. H. TITTMANN, ASSISTANT IN CHARGE OF WEIGHTS AND MEASURES. Washington; Government Printing Office. 6 pages.

Mr. Tittmann here discusses the work of various authorities who have compared the yard and the meter, and by referring all the observations to a common standard has succeeded in reconciling the discrepancies within very narrow limits. The following are his results for the number of inches in a meter according to the comparisons of the authorities named:

1817.	Hassler	39.36994 inches
1818.	Kater	39.36990 "
1835.	Baily	39.36973 "
1866.	Clarke	39.36970 "
1885.	Comstock	39.36984 "

The word inch here means one-thirty-sixth part of the British standard imperial yard, and the word meter means the length of an iron bar owned by the American Philosophical Society, which is usually called the "Committee Meter." This committee meter is the standard of metric measures used by the Coast and Geodetic Survey, but unfortunately its length is slightly different from that of the archive meter of Paris. The mean, of the above values is 39.36982 inches, which may now be taken as the probable mean value of the committee meter expressed in terms of the British standard imperial yard. If we understand correctly the remark of Mr. Tittmann concerning the archive meter, its probable length in terms of the same yard should be about 39.36983 inches.

THE DAFT SYSTEM OF ELECTRIC RAILROADS AND DISTRIBUTORY POWER PLANTS.

These are descriptive pamphlets of the systems of electric propulsion which the Daft Electric Light Company is introducing. They each give a brief history of the introduction and use of electricity, locomotion, and the distribution of power. The engravings are excellent and the printing superb. Their defect, however, which is common

to many trade catalogues, is that the writer has assumed that the reader knows much more about the subject treated of than is usually the case. If the author or authors had elucidated the subjects more fully, the pamphlets before us would have been much more interesting reading, and be a great deal more useful to the reader and to the Company which has issued them. Generally readers are fully as much or more interested in knowing how things are done as they are in what has been accomplished. The extent to which power is being distributed is, however, surprising many people, and the publication before us gives some very interesting information on this subject.

THE BERLIN IRON BRIDGE COMPANY: CATALOGUE, 1889. East Berlin, Conn.; published by the Company.

This catalogue contains a number of excellent engravings of bridges of different classes, truss, girder, and suspension, erected by this Company, and also of a number of iron roofs, bridges, and other structures. It has also an introduction intended to set forth the merits of the parabolic truss used by the Company in a large number of its bridges, giving the reasons why this truss should be preferred, and a short chapter on the relative economy of iron and wooden bridges for highway purposes.

The illustrations are all made from photographs and show a number of street and highway bridges of different spans and classes, and give a very fair idea of the great variety of work done by the Company.

HINTS ON HOUSE BUILDING: BY ROBERT GRIMSHAW, M.E.; published by the Practical Publishing Company, 21 Park Row, New York City.

This book consists of extracts mostly reprinted from the *Mechanical News*, and is published without any attempt at classification; but the Author, who is a practical engineer, has aimed to present hints on this important subject, which will be of use and interest to the public, and will stimulate readers to improve their present surroundings. Some of Mr. Grimshaw's hints are serviceable; with others many people will be inclined to find fault, but at any rate they are worth reading by those who intend to build.

BOOKS RECEIVED.

FIRST ANNUAL REPORT OF THE STATISTICS OF RAILROADS IN THE UNITED STATES TO THE INTERSTATE COMMERCE COMMISSION, FOR THE YEAR ENDING JUNE 30, 1888: HENRY C. ADAMS, STATISTICIAN TO THE COMMISSION. Washington, D. C.; Government Printing Office. Reference is made to this publication more at length in another column.

PRACTICAL BLACKSMITHING: A COLLECTION OF ARTICLES CONTRIBUTED BY SKILLED WORKMEN TO THE BLACKSMITH AND WHEELWRIGHT. COMPILED AND EDITED BY M. T. RICHARDSON. VOLUME I. New York; M. T. Richardson, 84 & 86 Reade Street (Price, $1).

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; issued by the Institution. The present installment includes Alternate-Current Machinery, by Gisbert Kapp, with an abstract of the discussion on the paper; Indian Railways, the Broad and Narrow Gauge Systems Compared, by Francis Waring, also with an abstract of discussion; the Tides in the Neighborhood of Portsmouth, by Bernard O'Driscoll Townsend; Tests of a Westinghouse Engine, by Stephen Alley; Steamers for Winter Navigation and Ice Breaking, by Robert Runeberg; Stress-Diagrams of Solid Structures, by Professor Robert Henry Smith.

THE DISTRICT DISTRIBUTION OF STEAM IN THE UNITED STATES: BY CHARLES E. EMERY, OF NEW YORK. London, England. Published by the Institution of Civil Engineers. This is a paper read by Mr. Emery before the Institution of Civil Engineers, and is accompanied by an abstract of the discussion on the paper.

HERZOGLICHE TECHNISCHE HOCHSCHULE CAROLO-WILHELMINA ZU BRAUNSCHWEIG: PROGRAM FÜR DAS STUDIENJAHR 1889-1890. Braunschweig, Germany. This is a programme of the course of studies pursued at the Ducal High School of Braunschweig, Germany, a technical school which has an excellent reputation on account of the thoroughness of its courses and the high professional standing of many of its Professors.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, JULY, 1889. Ithaca, N. Y.; published by the University.

THE SEVENTEENTH ANNUAL REPORT OF THE PENNSYLVANIA COMPANY, FOR THE YEAR ENDING DECEMBER 31, 1888. Pittsburgh, Pa.; issued by the Company.

THE WESTINGHOUSE AIR BRAKE COMPANY. SUPPLEMENT TO CATALOGUE. Pittsburgh, Pa.; published by the Company. This supplement to the catalogue has been issued by the Westinghouse Air Brake Company, and announces an important and considerable reduction—varying from 4 to 23 per cent.—in the prices of air-brake material.

THE AMERICAN ELECTRIC COMBINATION LOCK: DESCRIPTION. This is a description of an apparatus for electric signaling and other purposes, invented and patented by Mr. A. A. Hatch, of Kansas City, Mo., and includes some account of experiences had with it on various Western railroads.

THE WORTHINGTON HIGH DUTY PUMPING ENGINE AT THE UNIVERSAL EXPOSITION OF 1889: BY HENRY R. WORTHINGTON. New York, London, Berlin and Paris; Henry R. Worthington. This is a pamphlet descriptive of the Worthington Exhibit of pumps at Paris; it is fully illustrated, and the descriptive matter is in both French and English.

ILLUSTRATED CATALOGUE OF PERFORATED VENEER SEATINGS, CHAIRS, SETTEES, ETC. New York; Joel H. Woodman & Company.

POINTS ABOUT DRAWING INSTRUMENTS: BY THEODORE ALTENEDER. Philadelphia; published by the Author.

ELECTRICAL DISTRIBUTION OF LIGHT, HEAT, AND POWER: BY HAROLD P. BROWN, ELECTRICAL ENGINEER. New York; published by the Author.

WARNER AND SWASEY'S ILLUSTRATED CATALOGUE OF IRON AND BRASS-WORKING MACHINE TOOLS. Cleveland, O.; July, 1889.

ABOUT BOOKS AND PERIODICALS.

THE June number of the PUBLICATIONS of the American Statistical Association includes articles on American Railroad Statistics, by Professor Arthur T. Hadley, and on Statistics of Municipal Finance, by Professor Henry B. Gardner, with the usual book notices and other miscellaneous articles. Professor Hadley's article is well worth reading, and emphasizes the fact to which we have heretofore called attention, the lack of complete and reliable railroad statistics in this country.

In HARPER'S WEEKLY for August 10 there is a timely article on Roads and Road-making, by Francis F. V. Greene, containing much practical information on the subject and well illustrated.

Among the recent publications of John Wiley & Sons, New York, are a text-book on the METHOD OF LEAST SQUARES, by

Professor Mansfield Merriman. The book is based on Professor Merriman's former work on the same subject, but is so enlarged and altered as to be practically a new treatise.

The electric article in SCRIBNER'S for August is by President Morton, of the Stevens Institute, and is on the Electric Light, treating of its gradual evolution and its present standing as an important industry.

HIRAM MYRON BRITTON.

THE announcement in the daily papers of the death of the former President of the Master Mechanics' Association, which occurred at his home in Oswego, N. Y., on August 10, has been read with sincere sorrow by his many friends and acquaintances, who are to be found in all parts of this country. He was for many years a prominent railroad officer, but he was more generally known by reason of his connection with the Master Mechanics' Association, as its President for nearly ten years.

He was born at Littleton, Mass., November 30, 1831, and was therefore 58 years old at the time of his death. While he was quite young his parents moved to Concord, Mass. He entered the service of the Fitchburg Railroad about the year 1848. In 1851 he was advanced to the responsible position of a locomotive engineer, which he filled very creditably to himself and to the satisfaction of his employers, for about 10 years. In 1861 he was appointed Master Mechanic on that road, but in 1865 he resigned that position to accept a similar one on the Indianapolis, Cincinnati & Lafayette Railroad, with his office in Cincinnati. In June, 1868, a preliminary meeting of Railroad Master Mechanics was held in Dayton, O., and another one a few weeks later at Cleveland, "for the purpose of taking action to organize an Association of Master Mechanics." Mr. Britton was present at both of these meetings and acted as Secretary. On September 30 of the same year another meeting was held in Cleveland, and a permanent organization was then effected, and Mr. Britton was elected President. He held this office until 1877, when he resigned. In 1870 or 1871 he was appointed Superintendent of the White Water Valley Railroad, with his office still in Cincinnati. In 1876 he was offered the position of Superintendent of the Eastern division of the New York & New England Railroad. Like many another son of New England, the temptation of going back to his native hills was irresistible, and he accepted the appointment, making Boston his home. He held the place on this road until 1880 or 1881, and was then made Superintendent and Manager of the New York, Susquehanna & Western, with his office in New York City. In 1883 he was made General Manager of the Rome, Watertown & Ogdensburg Railroad, which position he held up to the date of his death, although for a year or more past he was unable to attend actively to the duties of the office. In the autumn of 1887 an accident occurred on the road which required his supervision in clearing it away. He exerted himself violently at the time, and being in a profuse perspiration contracted a very severe cold, which was the eventual cause of his death. When his health began to fail he made a journey to Europe, and came back apparently so much improved that he resumed his duties on the railroad. After a while new indications manifested themselves, showing that his strong physical constitution had been undermined. In last November he went to Europe a second time and spent the winter in the South of France, with the hope of restoring his shattered health. The hope was, however, a vain one, and he returned to his home a few months ago only to end his days there.

He was a man of striking personal appearance, with a physique which, in his prime, was often envied by those who were apparently of frailer structure. He was a man of great energy and decision of character, gifted with a wonderful memory, and a remarkable aptness of understanding quickly certain traits in the characters of those with whom he came in contact, and divining their motives of action. The success and growth of the Master Mechanics' Association was largely—it may be said chiefly—due to his zeal and skill in conducting its affairs. Some one remarked that as the presiding officer, he had undisciplined troops to command, and he seemed to have the capacity of getting the best available service out of them. His presence in the chair was a stimulant to those on the floor, which has sometimes been sadly missed since he laid down the gavel. He was an earnest member of the order of Masons, and took an active part in its proceedings. He was a genial friend and companion, and was intensely zealous in the interests of his employers. During his administration the stock of the Rome, Watertown & Ogdensburg Railroad advanced in value from 18 to above par.

He has left a widow, two brothers—Isaac, who is in the town of Britton, Dak., and Augustus W., who is in Richland, N. Y.—and three sisters, Mrs. Daniel R. Hartwell and Mrs. Otis Hoyt, of Elgin, Ill., and Mrs. Charles W. Rogers, of Waltham, Mass.

ELECTRIC MOTORS.

THE following statements, which give an excellent idea of the part which the electric motor can be made to perform in our industrial system, are published in the Boston *Journal of Commerce* as extracts from a letter written by Mr. F. L. Pope, of New York, the well-known electrical engineer:

One of the ablest modern writers on industrial questions lays down the proposition, that the limitations of the advantages derived from the use of any form of force for industrial purposes are fixed by the possibility of distributing the power cheaply and economically, and, furthermore, that of the two factors, the power to distribute cheaply is of far greater importance than the power to produce cheaply. In illustration of this proposition, consider the cheapest source of energy now known—namely, the power of falling water. It has not been found possible to effect the distribution of this form of power except over very limited areas, from which it follows that all the industrial benefits derived from water power have necessarily been concentrated in the immediate vicinity of the point of its origin, and hence, when such places have been conveniently situated in other respects, they have acquired great industrial and commercial importance. Such instances may be found at Lowell, Lawrence, Manchester, Fall River, Holyoke, etc.

On the other hand, there are instances of very extensive and valuable water powers which cannot commercially be utilized, by reason of their geographical or topographical situation, such, for example, as the water power at Falls Village, Conn., one of the finest in New England, which is practically unavailable because there is not level ground enough in the vicinity to afford sites for the necessary factory buildings, tenements, and adjuncts.

Scattered all over New England, and, in fact, most of the Atlantic States, are innumerable mill sites of from 50 to 1,000 H.P., many of which were improved in former days, but which are now lying idle and contributing nothing to the industrial wealth of the community, by reason of their remoteness from modern facilities of transportation and other inconveniences of their situation. Every horse-power of energy thus running to waste would be worth to the community from $50 to $100 per year, were it so situated as to be utilized to the best advantage.

It is manifestly an important part of the mission of modern electrical development to render all this waste power once more available for industrial purposes. Every increase in the limits of the economical distribution of power increases the opportunity for employment, adds to the ease, convenience, and comfort with which the artisan accomplishes his work, and enlarges the surplus wealth for the community.

The two countries which have made by far the greatest advances in the utilization and distribution of electric power are Switzerland and the United States. It is well known that Switzerland is disadvantageously situated as a manufacturing country, for the reason that, although it is supplied with an almost unlimited number of the finest

water powers in the world, situated upon unfailing streams fed by the melting of Alpine snows, yet these are located, in almost every instance, in inaccessible valleys and ravines, where economical transportation of heavy products is impossible. The railroad lines are situated in the main valleys at too great a distance from the water powers, in the majority of cases, to render them of much value. Steam power, on the other hand, is expensive, as there are no coal-mines in the republic, and the coal used must be brought many hundred miles and up heavy grades, which render it so costly that the Swiss manufacturers have been unable to compete successfully with those more favorably situated in countries in closer proximity to the iron and coal districts. The manufactures of Switzerland have, for this reason, heretofore been confined to the lighter and more delicate varieties of machinery, in which the cost of labor is the principal element and the cost of transportation an inconsiderable one.

The recent introduction of methods of transporting and distributing power by electricity is rapidly changing this state of affairs, and in a few years it is probable that Switzerland will become one of the foremost manufacturing countries of Europe in all those varieties of industry in which cheap power is an important element, such as the manufacture of steam-engines, locomotives, and heavy machinery, of paper, cotton and woolen goods, and the like.

In the ancient city of Solothurn, in the northwestern part of Switzerland, there is a manufactory of machine screws which is driven by an electric motor of 50 H.P., which derives its energy from a turbine wheel which is situated on a mountain stream at a distance of over five miles from the works. The electric current is conveyed upon wires not larger than an ordinary lead-pencil, suspended upon poles on the public highway. No one would notice any difference between this line and the ordinary telegraph line, and, in fact, there is no difference, except that the construction is rather more substantial and the insulation more carefully attended to. The proprietor of this factory informed Mr. Pope that his electric motor had been running 11 hours a day for over two years and had never been out of order for a moment, and had required no repairs; he could not say too much in its praise.

The same gentleman also visited a delaine mill at Derendingen, Switzerland, of 36,000 spindles and the necessary complement of other machinery. This factory was driven by a pair of electric motors of 280 H.P., deriving their energy from a turbine wheel situated about 1½ miles from the factory, the connection being made by a line of insulated copper wire similar to the one at Solothurn. The manager of this factory told exactly the same story. He had never had any trouble whatever with the motors, that had been running for a year without repairs, and appeared likely to run for an indefinite length of time. He considered it far superior to any other form of power, especially in the manufacture of the delicate white woolen goods, in which the absence of the smoke, cinders, and dirt from a steam-engine was a particularly desirable condition. This is also the case in paper-making and other industries of like character. The cost of this electric installation at Derendingen, including the electric generators, electric motors, and connecting conductors, was about $15,000 of our money, or about $54 per effective horse-power. The cost of attendants, repairs, and maintenance is trifling.

There are several other instances of electric power transmission in Switzerland. One of these, at Lucerne, carries 120 H.P. half a mile, and another 250 H.P. a quarter of a mile. From what Mr. Pope saw, it was quite clear that there could be no possible difficulty in conveying even 1,000 H.P. at least a distance of five miles, and there is no reason to suppose that this distance is anywhere near the possible limit which may be attained.

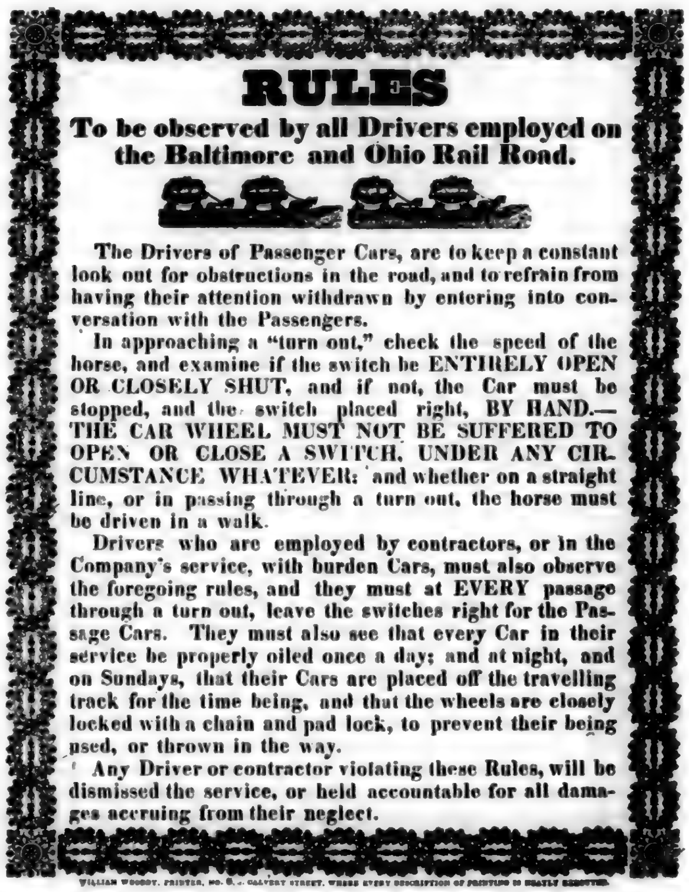
The installations described were put in by the Oerlikon Machine Company, whose works are near Zurich, and employ about 800 men. The visitor was informed that, in consequence of the success of the plants at Solothurn and elsewhere, their books were crowded with orders, and, especially, that they had received an order from Northern Italy for a much larger plant than any which had yet been erected.

We have no examples in the United States of anything like this amount of power being transmitted and utilized by a single motor. The writer says he does not know of any motor which has yet been set up of over 60 H.P. The development of power transmission in the United States has been mainly in the direction of distribution from a common source of energy to many small motors. Recent returns afford a basis for an approximate estimate that there are as many as 6,000 electric motors to-day in use in the United States, for industrial purposes. These have a capacity varying from the small one-sixteenth H.P. which is used to drive a family sewing-machine up to the 50 and 60 H.P. Motors employed in mining and milling works. One of the most common and favorite sizes is 10 H.P., of which large numbers are in use in New York, Boston, Baltimore, Rochester, and many other places.

Every manufactory of electric motors in the United States is crowded to its utmost capacity in its efforts to meet the constantly increasing demands for electric power. Mr. Pope thinks it is, apparently, only a question of time, and not a very long time, either, when it will be difficult to find in any city a steam-engine of less than 50 H.P. capacity, the demand for smaller powers being met so much more conveniently and economically by the electric motor.

THE BALTIMORE & OHIO RAILROAD IN THE OLDEN TIME.

THE following is a reduced copy of printed rules issued by the Baltimore & Ohio Railroad before the days of locomotives. The copy, which was found among some old



RULES

To be observed by all Drivers employed on the Baltimore and Ohio Rail Road.

The Drivers of Passenger Cars, are to keep a constant look out for obstructions in the road, and to refrain from having their attention withdrawn by entering into conversation with the Passengers.

In approaching a "turn out," check the speed of the horse, and examine if the switch be ENTIRELY OPEN OR CLOSELY SHUT, and if not, the Car must be stopped, and the switch placed right, BY HAND.—THE CAR WHEEL MUST NOT BE SUFFERED TO OPEN OR CLOSE A SWITCH, UNDER ANY CIRCUMSTANCE WHATEVER: and whether on a straight line, or in passing through a turn out, the horse must be driven in a walk.

Drivers who are employed by contractors, or in the Company's service, with burden Cars, must also observe the foregoing rules, and they must at EVERY passage through a turn out, leave the switches right for the Passage Cars. They must also see that every Car in their service be properly oiled once a day; and at night, and on Sundays, that their Cars are placed off the travelling track for the time being, and that the wheels are closely locked with a chain and pad lock, to prevent their being used, or thrown in the way.

Any Driver or contractor violating these Rules, will be dismissed the service, or held accountable for all damages accruing from their neglect.

papers in the possession of Mr. Horatio Allen, is not dated, but it was among some other documents dated 1828, and probably the "Rules" were in force on the Baltimore & Ohio about that time. The copy we print has been reduced from the original somewhat more than half the linear scale.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

BY LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

(*Continued from page* 363.)

PART III.—MODERN RIFLED GUNS AND PROJECTILES.

I.—RIFLED ORDNANCE.

THE first decided step in the development of the heavy gun, as of the small-arm, was in converting it from a smooth-bore into a rifle.

The advantages of a rifled over a smooth-bored fire-arm are too well known to call for elaborate description. Briefly stated, these advantages may be summed up in the two qualities—greater range and greater accuracy. From a ballistic standpoint these two qualities cover about the whole field of efficiency of any arm, large or small. The greater range of a projectile implies the possession of superior living force, or stored-up energy or capacity for work; whether this energy is expended in overcoming the resistance of the air or in battering down a wall or in piercing armor is immaterial. Greater accuracy means, of course, the ability to do better and more reliable work, and is of scarcely less importance than the other.

Even with spherical projectiles the advantage of giving them a rifle motion is pronounced, although far less than with those of elongated form. A spherical projectile, however carefully made, will never be perfectly homogeneous; the centres of figure and of inertia will never exactly coincide; there will always be certain inequalities upon the surface to offer unequal resistance to the air, hence the flight of a spherical projectile from a smooth-bore gun can never be accurately predicated. If, however, you give the same projectile a rapid rotary motion, it is easily seen that inequalities both of figure and surface are neutralized and the missile becomes practically homogeneous, to say nothing of the superior ability a body so circumstanced will possess for overcoming atmospheric resistance.

But the great advantage a rifle possesses over a smooth-bore gun lies in the fact that it enables us to employ other than spherical projectiles. With projectiles of the same caliber, or which will offer the same cross-sectional area to the resistance of the air, we can, by giving them an elongated form, obtain from three to five times the weight of metal. This implies an enormously increased ability to overcome the resistance of the air, or to do other work. Another advantage is that we can give to the head of our projectile such a shape as will offer the least resistance to this atmospheric retardation.

Efforts innumerable have been made to employ oblong projectiles in smooth-bore guns. The resistance of the air, acting as it does upon the head of a projectile, while the center of inertia is well to the rear, will invariably cause it to turn end for end, or revolve about its shorter axis, unless some force more powerful can be brought to bear to overcome this inclination. If it were possible to concentrate the weight of the metal at the point of a projectile there would, of course, be no tendency to "tumble." As this is practically impossible, stability must be secured in one of two ways—either by giving the projectile a rotary motion about its longer axis sufficiently strong to overcome this tendency, or by giving it some peculiar shape, so that the action of the air may itself keep it true in its flight.

Rotary motion may be imparted to a projectile thrown from a smooth-bore gun (1), by the action of the powder gas upon the shot inside the bore, or (2) by the pressure of the air upon the projectile after it has left the bore. The scores of models in our Patent Office provided with spiral flanges, or spiral grooves cut upon the exterior or running through the metal of the projectile, show how persistent has been the effort in this direction. To obtain steadiness of flight without a resort to rotary motion, wings, straight grooves, and flanges of various shapes have been employed, with the expectation that the pressure of the air upon the sides or along the grooves would be sufficient to keep the projectile head on. Many experiments have been tried with these various projectiles, but no satisfactory results have ever been obtained.

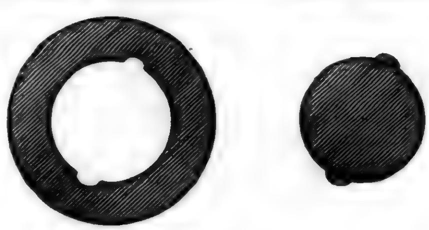


Fig. 1.

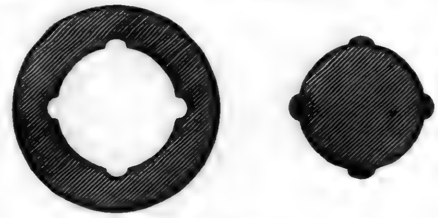


Fig. 2.

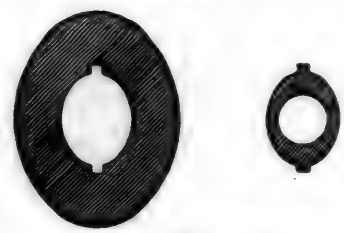


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

In rifled guns rotary motion is imparted to the projectile in but one way, that by some mechanical means inside the bore of the gun. The various methods employed to attain this end are called systems of rifling. The degree of twist given to the grooves and the length and form of the projectile depend upon the work to be required of the gun rather than upon the system upon which it may be rifled.

Four different systems of rifling have at different times been employed: (1) by giving a peculiar form to the bore of the gun itself, as that of a twisted ellipse or hexagon, with projectiles of corresponding shape; (2) by means of two or more deep grooves, with projectiles having corresponding studs or ribs to fit; (3) by means of numerous shallow grooves, and providing the projectile with a soft metal cap or envelope which is expanded into the grooves by the powder gas, used only in muzzle-loading guns; and (4) breech-loading guns with shallow grooves, with projectiles having a soft metal band or coating somewhat larger than the diameter of the bore, into which it is compressed by the powder gas. The first and second systems are suitable for either breech or muzzle-loading guns.

The "twist" which it is necessary to give to a projectile in order to maintain its stability, or the velocity of rotation, as it is called, will vary with its caliber and initial velocity, as well as with the shape, the density and the position of its center of gravity. The higher the initial velocity the greater will be the resistance of the air, and the greater the inclination to tumble; hence, if you increase the velocity, other things being equal, the twist of your

rifling must be correspondingly increased. Again, a long projectile will require a sharper twist than a shorter one; a light projectile than a heavier one of the same caliber. There is, therefore, no general rule that can be laid down as governing the proper twist for a rifle. It must be decided by the caliber of the piece and the work it will have to do.

The measure of this twist will be the length of one complete revolution of the spiral. This is usually measured in terms of the diameter of the bore. Some of the earlier cannon had a twist of one turn in 65 calibers, while some of the later systems reduce it to but little more than a third of this figure. In nearly all the earlier systems the twist was uniform, but at the present date an increasing twist has been almost universally adopted. It has the advantage of relieving the chamber of the piece from some extra strain during the first instants of the combustion of the charge.

The development of a uniform groove would be the diagonal of a rectangle, whose base is the circumference of the bore. A variable groove would be obtained by following the line of an arc of a circle wrapped around the surface of the bore. The curve used in both our new Army and Navy guns is that of a semi-cubical parabola. The same curve is also employed in some foreign systems of rifling.

The first rifled cannon, that of Major Cavalli, referred to in a previous article, was rifled with his deep grooves, with corresponding projections upon the projectile, as shown in fig. 1. This was improved upon by Captain Gillion, of the Belgian Artillery, who substituted four grooves and four projections for the two of Cavalli; this is shown in fig. 2. Another plan was proposed by an Italian officer, Saint Robert, which was novel in that by so arranging the metal in his projectile, which was hollow, he gave it a revolution about its shorter axis and parallel to the plane of fire, instead of perpendicular, the grooves being without twist, as shown in fig. 3.

The first rifle to receive actual test in war was the English Lancaster gun. The bore was elliptical in its cross-section, with a corresponding shape to the projectile. This is shown in fig. 4. The first guns of this system were rifled with an increasing twist, but owing to the proneness of the shot to jam, a uniform twist to the ellipse was afterward adopted, making one-quarter of a turn in the length of the bore. The system, however, did not survive the Crimean War. This belonged to the first system of rifling previously mentioned, as did also the Whitworth, which was developed about the same time.

In the Whitworth system the bore is of the form of a spiral, or twisted hexagon, fig. 5. This system of rifling is still adhered to in all Whitworth guns. The projectiles are made without studs or coating and are turned accurately to correspond with the bore. The rear portion is tapering, thus giving a bearing surface of about half the length. Guns rifled upon this system have the advantage of imparting the rotary motion to their projectiles, with a certainty not always attained in any other system.

The earlier French and the Woolwich systems of rifling belong, as do those first mentioned, to the second class. In the French system there were six spiral grooves in the bore of the gun, and the projectile had six corresponding rows of zinc studs, two in each row, as shown in fig. 6. The Woolwich system was almost identical with the French, except that the grooves in the bore were three or more, corresponding to the caliber of the gun.

In the Austrian service of this date, which was that of 20 years ago, the grooves were saw-shaped, the projectiles having soft metal ribs to fit the grooves; this is shown in fig. 7.

In the Prussian system, which belonged to the third class, the grooves were numerous and wider at the bottom of the bore than at the muzzle. The body of the projectile was cast with under-cut projecting wings, over which was cast a coating of lead. When the shot was driven toward the muzzle on discharge the soft coating was forced into the grooves, or *stagged*, as it is called, and gave to it a rotary motion corresponding to the twist, which in this system was one turn in fifty calibers. This system is shown in fig. 8.

To secure greater accuracy various methods have been devised to *center* the projectile—that is, to cause it to leave the bore with its axis perfectly true with that of the bore. The Armstrong *shunt* system is the one of this character best known. In it the grooves at the muzzle are double, the half on the right, or driving side, being comparatively shallow, an incline leading from the deep to the shallow part. The projectile was provided with copper studs which, when it passed down the bore from the muzzle, followed the deeper half. When, however, the projectile was driven out, the studs following up the incline were forced into the shallower half, compressed and the projectile accurately centered, as indicated in fig. 8½.

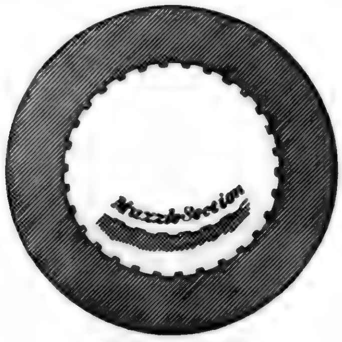


Fig. 8.

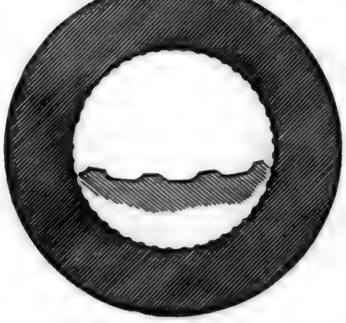


Fig. 9.

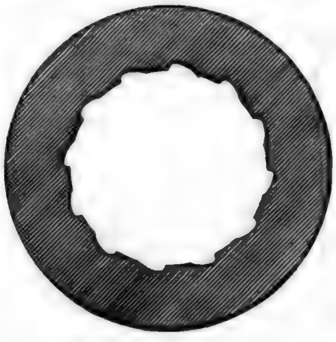


Fig. 10.

With muzzle-loading rifles the method almost universally employed is to provide the shot with a cup or band of soft metal, usually copper or brass. This is forced by the action of the powder gas into the grooves, which are more numerous and shallow than in the stud or rib systems. In the United States this has been the only system followed. The Parrott rifles had from 9 to 15 grooves, according to caliber, 0.1 inch deep and with an increasing twist. The projectiles were provided with a narrow ring of brass, flush with the base of the shot, which was forced outward on discharge. The Butler sabot is the one now most used.

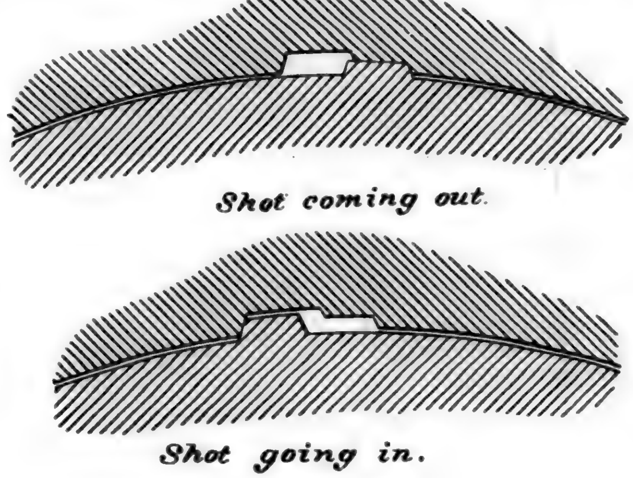


Fig. 8½

It consists of a bronze ring screwed upon the base of the projectile. An annular groove is cut in this ring, in which the powder gases act to force the exterior rim into the grooves. This is shown in fig. 11. The Eureka sabot is also in use in our service. Its construction is shown in fig. 12.

Following the general introduction of breech-loading ordnance a change in the systems of rifling, or rather in the methods employed for giving rotation to the projectile followed. Under what is classed as the fourth, or breech-loading, system, the grooves of the gun are numerous and shallow; the projectile has soft metal bands or coating of a slightly greater diameter than the bore. The disadvantages of using a lead coating for projectiles, which was at one time extensively done, were so great that it has now been entirely abandoned, and the use of one or two bands of soft metal has become universal.

Where two bands are employed the front one has a diameter equal to that across the bands, and acts simply as a centering band, while rotation is communicated by the band at the bore. In the French service the front band is replaced by a slight swelling of the metal of the projectile. Fig. 13 shows the rotation band of our 8-in. Army rifle projectile; in this case a battering or armor-piercing

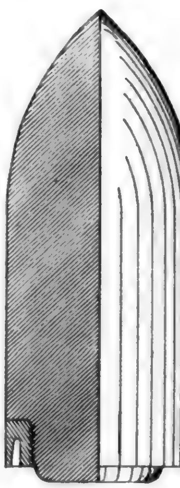


Fig. 11.

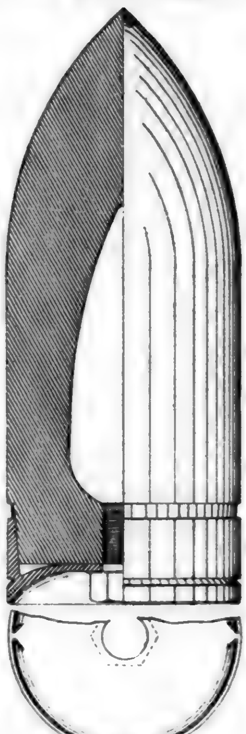


Fig. 12.

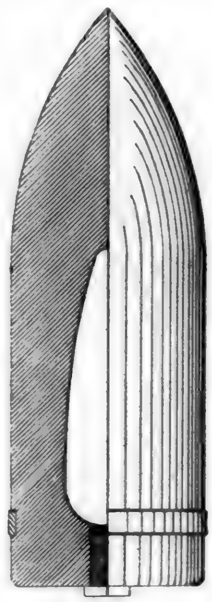


Fig. 13.

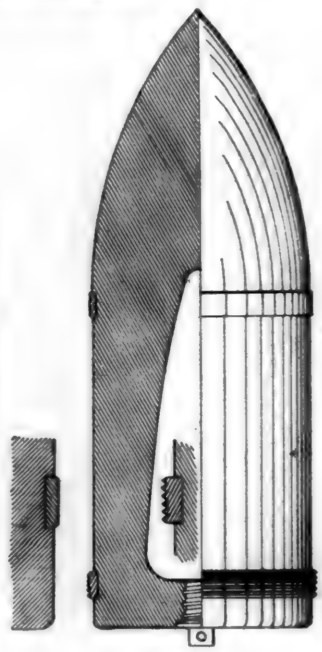


Fig. 14.

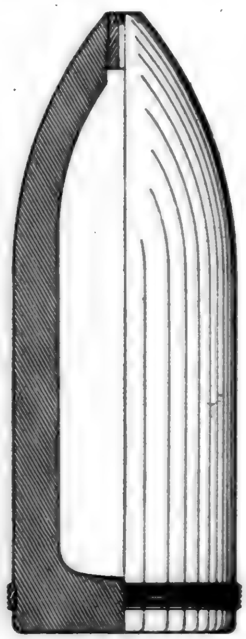


Fig. 15.

shell. The band is of soft copper, and as shown is forced into an undercut groove. The band is prevented from slipping by depressions or cups cut at intervals along the inner surface of this groove. Figs. 14 and 15 show two Krupp projectiles, the former, the battering shell, provided with two bands; the forward one being simply a centering band. The rear band is serrated to facilitate its taking hold of the grooves. The latter is the common shell, and has but the single rotation band.

The 110-ton Elswick gun is poly-grooved, with an increasing twist, beginning at the breech, with one turn in 120 calibers, and ending at the muzzle with one turn in 56 calibers. All the recent models of German (Krupp) guns have the increasing twist. The 119-ton Krupp has 92 bands and grooves. Our 8-in. Army rifle has 45 bands and grooves, with a pitch at the origin of one turn in 70 calibers, which increases to one in 25 calibers up to within 16 in. of the muzzle, where it becomes uniform. This is shown in fig. 9. The 8-in. Navy rifle has 12 peculiar-shaped grooves, which increase from zero at the origin to one turn in 25 calibers at the muzzle; this is indicated in fig. 10.

(TO BE CONTINUED.)

AN ENGLISH EXPRESS ENGINE.

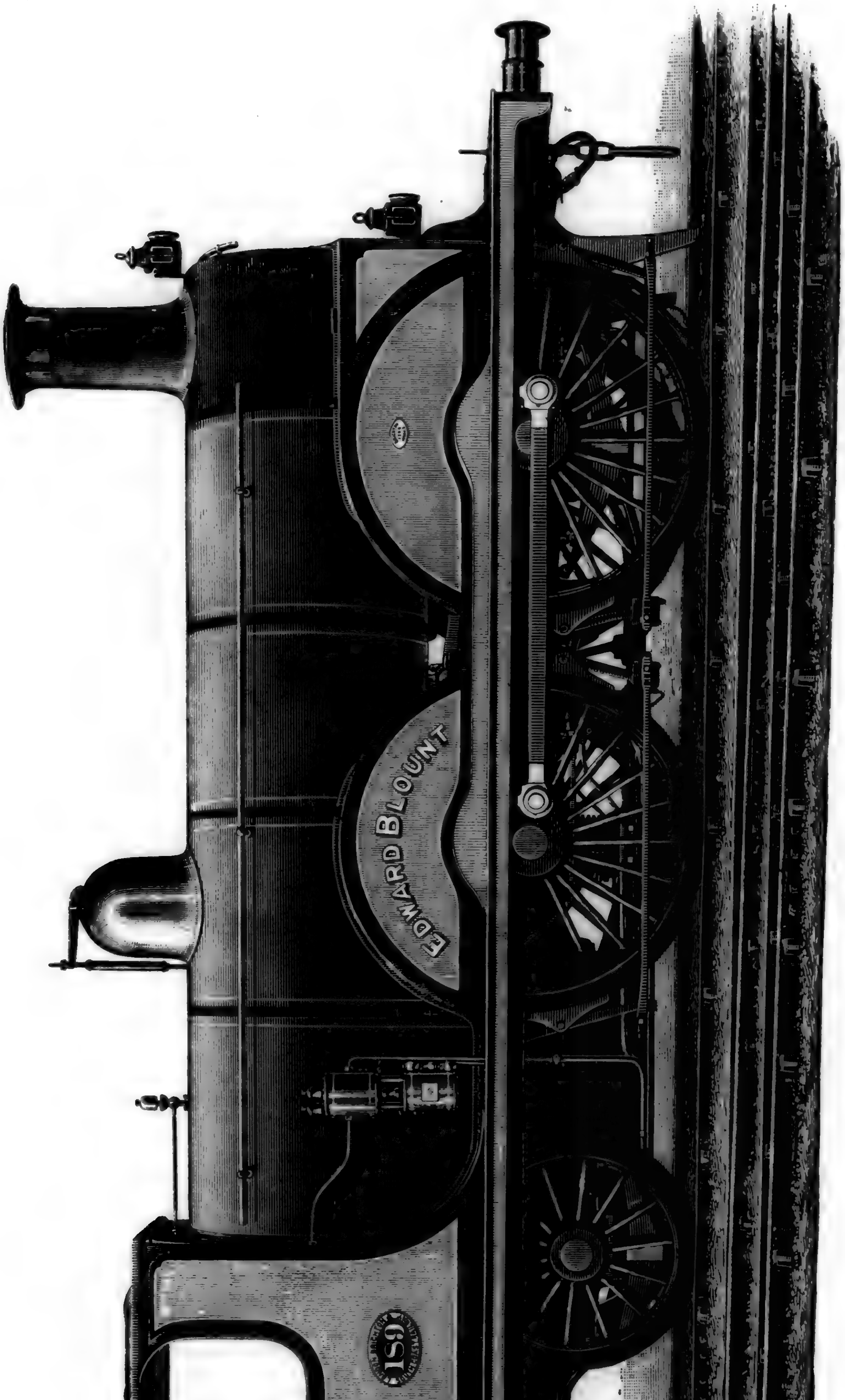
(From the London *Engineer*.)

THE accompanying illustration shows an express passenger locomotive shown at the Paris Exposition, by the London, Brighton & South Coast Railway Company and built in the Brighton Shops of that Company, from the designs of Mr. W. Stroudley, the Locomotive Superintendent of the Road. The engine is of what has been called by the Company the *Gladstone* Class, from the name of the first engine of the type put in service. The railroad, extending from London to Brighton, has a class of passenger traffic which makes it necessary to run its trains at high speed and also requires heavier trains than are usual on English railroads. The present engine follows the design of the original *Gladstone*, with some slight differences which have been suggested by experience.

As will be seen from the engraving the engine has inside cylinders and four coupled wheels, with a single pair of trailing wheels behind the fire-box. Its general dimensions are as follows:

Diameter of cylinders		18¼ in.
Stroke of cylinders		26 "
Lap of valve		0⅞ "
Lead of valve, in full gear		0 3/32 "
Distance of cylinders apart		25 "
Diameter of driving-wheels	6 ft.	6 "
Diameter of trailing-wheels	4 "	6 "
Distance, center of main drivers to center of leading-wheels	7 "	7 "
Distance, center of main drivers to center of trailing-wheels	8 "	0 "
Total wheel-base of engine	15 "	7 "
Total wheel-base of engine and tender	38 "	9½ "
Length of engine and tender over all	51 "	10 "
Mean diameter of boiler barrel	4 "	5 "
Length of boiler barrel	10 "	2 "
Number of tubes		333
Outside diameter of tubes		1½ "
Length of fire-box, outside	6 "	8¼ "
Grate area		21 sq. ft.
Heating surface, fire-box		114 " "
Heating surface, tubes		1386 " "
Heating surface, total		1500 " "
Usual working pressure		150 lbs.
Total weight on coupled wheels		63,450 "
Total weight of engine		86,700 "
Total weight of engine and tender		147,850 "
Water capacity of tender tank		2,250 gals.

It is further stated that the average temperature of the feed-water in actual service is 145°, and the average quan-

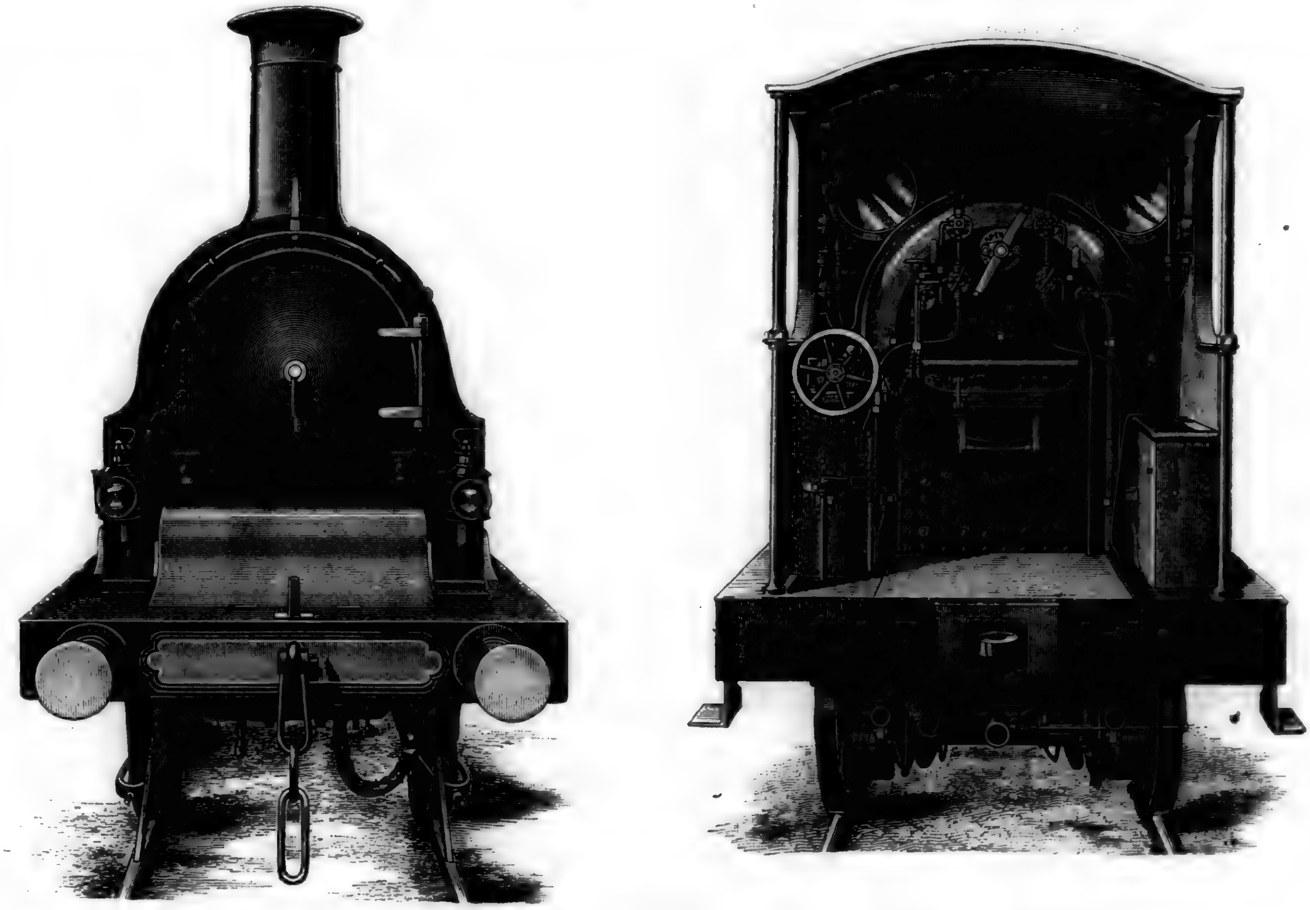


EXPRESS PASSENGER LOCOMOTIVE, LONDON, BRIGHTON & SOUTH COAST RAILWAY.

tity of water evaporated per pound of coal is 12 lbs. The maximum schedule time of the trains, on which this engine is run, is 46½ miles an hour, and the longest run without stop is 86 miles. The maximum number of carriages hauled is 26, and in this case the total weight of the train, including the engine, is 378 tons. The average coal consumption of 18 engines of this class was 28 lbs. per mile run.

Of the changes made from the original pattern in the present engine, the most important one is in the steam-chest. Mr. Stroudley considered it judicious to increase the width of the steam ports from 15 in. to 16 in., and the length from 1⅞ in. to 1½ in.; This is to enable the engine to get rid of the steam more freely with very heavy loads. In doing this he has removed the sides of the steam-chest altogether, and has left the valve faces on the same plane as the steam-chest cover joint; the steam-chest cover itself being made of semi-circular form, having the stuffing-box required in the length of the valve spindle, as this washer can readily be turned to the exact thickness necessary. This renders the setting of the valves extremely easy.

The next alteration is in the reversing gear. The air cylinder for lifting the motion into back gear, instead of having a large balance weight as usual, works admirably. It was necessary, however, to have a circular rack fixed upon the screw, with a detent to retain it in position; and there was in addition a pinching screw to nip the nut solid to the guide when the engine was in motion, to prevent the chattering which takes place by the varying angle of the expansion link. This acts perfectly if the driver will use it; but it very often happens that he allows the engine to run held by the circular rack only; and this chatters away the thread of the reversing screw and nut. So Mr. Stroudley decided to put an air-brake to hold this, instead of the catches or pinching screws; and he makes a rec-



EXPRESS LOCOMOTIVE, LONDON BRIGHTON & SOUTH COAST RAILWAY.

for the valve spindles cast in it, so that when the steam-chest cover is taken off, the slide-valves, spindles, etc., are removed *en masse*, the joint remaining, however, of the same size as in the earlier engines. This reduces the cylinder casting, cheapens the construction, and offers a great number of facilities for handling. He has also provided the slide valves with three relieving rings on the back; these take away the major portion of the steam pressure from the valve faces. The valves themselves are carried on a slipper, which travels along with the valve and supports the same by means of four spiral springs. The slipper has three holes in the back, through which the relieving rings pass to work in contact with the face cast in the steam-chest cover, which has three small holes connecting the rings with the open air. The valve spindles are let into the intermediate link with a cone, fastened with a cotter in the usual way; but there is a hole drilled beyond the end of the cone, through which a taper pin can be driven to start the valve spindle after the cotter is taken out, rendering the disconnection of this detail very simple. The intermediate link is made separate from the guide and is attached to it by a nut, having a washer ½ in. thick placed so as to permit any slight adjustment that may be tangular-shaped washer with rounded corners and fits this to the nut, inside of which is placed a cup leather. A bent steel pipe conducts the air from the main reservoir into this cup leather, which has a holding power of about two tons, and which is amply sufficient to hold the gear quite solid. The small three-way cock, which sufficed for the reversing gear previously used, has been removed, and a flat valve having a three-ported face, something similar to the one which he made for the Westinghouse brake, is arranged in its place. When the handle of this is put forward it exhausts the main reversing cylinder and at the same time slackens the nipping gear. When it is put backward it also slackens the nipping gear and turns the air in behind the reversing piston, so as to bring the engine into back gear if necessary. When the handle of this valve is placed in the middle position it locks this gear at whatever point the driver may determine, and as there is no catch or other means of holding the reversing gear in position, it becomes absolutely necessary for the driver to lock it. Mr. Stroudley has no doubt, from the experience he has had, that this will be a vast improvement on anything of the kind which has hitherto been adopted, and will save a lot of wear and tear.

The difficulty of properly lubricating the slide-valves and pistons of locomotives has been felt by all connected with them, and Mr. Stroudley designed a lubricator which operates as a sight-feed lubricator, but is actuated by steam pressure taken direct from the boiler. It is automatic, but it can by a touch of the handle be used to let in oil when the engine is running down a bank with the steam shut off, when other lubricators will not act. The principle of the construction is a chamber filled with oil, and connected with a small steam pipe from the gauge fittings; this is passed into a larger pipe, which condenses water, which is forced by the whole pressure of the boiler into the bottom of the oil cylinder. The opening into the oil cylinder is, however, closed by a valve, which is pressed down by a strong spiral spring, and between the top end of this valve-spindle and spiral spring an elastic metal diaphragm is placed. So long as the steam is shut off the spiral spring forces down the diaphragm and also the valve, keeping the water under pressure from entering the oil cylinder. Immediately, however, the regulator is opened, the steam-chest pressure passes up and acts on the inside of the diaphragm lifting it up and also lifting the valve, permitting the water to pass into the oil cylinder, displacing the oil, which is passed along to the pistons and valves. The velocity with which this can operate is determined by a graduated cock conveniently placed for the driver to adjust, and the oil, passing down through a glass tube, enables him to judge exactly the quantity he is using. The oil passes along a pipe about ⅜ in. internal diameter down to the steam-chest, in which there is a stud placed having a main central hole drilled nearly through it, with two small holes drilled in the end at such an angle that they inject oil on to the faces of the valves and on to the spindles, thus applying the lubricant in the places where it is required. The spiral spring referred to, which holds down the valve against the boiler pressure, is kept in position by a very quick-threaded screw having a cross handle, and a very slight turn relieves the action and permits the oil to pass into the cylinders when steam is shut off.

The large grate surface and tube area of these engines naturally requires a powerful blast. To obtain this the chimney has to be made larger, as from the structural arrangements of the line it cannot be made higher; consequently, the action of an ordinary blast-pipe is not satisfactory when the diameter of the chimney becomes excessive. To remedy this, Mr. W. Adams, Locomotive Superintendent of the Southwestern Railway, has designed an annular blast-pipe which possesses two advantages. It gives an additional outlet for the gases in the smoke-box near the base of the blast-pipe, and it also increases very considerably the diameter of the steam jet, the external diameter of the annular jet of steam being 7⅝ in.; and by operating on the inside as well as on the outside, it gives a very much more efficient draft, without that sharpness which is induced by a small diameter of chimney and a solid jet of steam. A large number of these blast-pipes have been fitted on the Brighton Railway, and they are found to work very efficiently, the engine maintaining a full head of steam with the greatest ease.

It will be remembered that when the *Gladstone* was put to work, its safety-valves were loaded to 140 lbs. The *Gladstone* boiler, in common with all the boilers on this line made from Mr. Stroudley's design, was originally constructed to carry 150 lbs. pressure, and this is the standard pressure now adopted throughout the line in all the standard classes of engines.

With the load of 24 or 25 carriages which they have to run in the morning train from Brighton to London, and which has to do the 30 miles to Redhill in 40 minutes, notwithstanding that about 20 miles of the road is up gradients of 1:264, they require all the foothold that they can get; and after some considerable trouble Mr. Stroudley has adopted Messrs. Gresham & Craven's sanding apparatus, but, instead of turning on the steam to the sanding apparatus with a separate handle, Mr. Stroudley has connected the steam supply with the steam-chest; so that the driver can turn the handle for the sand into the proper position before he meddles with the regulator in starting; and the application of the steam to the pistons to drive the train also applies the sand to give foothold. This arrangement was designed by Mr. Stroudley's principal foreman, Mr. Jeffrey, and it answers the purpose admirably. It is found that this class of engine can run the 5 P.M. London to Brighton—a little over 50 miles—train with 17 to 18 coaches in 62 minutes from starting until stopping in the station at Brighton; this train is allowed 65 minutes, and the drivers frequently have as many as 20 carriages on, and keep exact time.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Concluded from page* 357.)

CHAPTER LVII.

DIMENSIONS OF STEAM-HAMMERS.

In the two tables accompanying there are collected the dimensions of a large number of steam-hammers of different sizes, showing at a glance the variations of practice among French, English and other European builders.

In these tables the dimensions given are metrical. Doubtless all our readers are familiar with the metrical measures, and in reading them it will be only necessary to bear in mind two dimensions—the meter = 39.37 in., and the kilogramme = 2.204 lbs. The reduction to feet and inches would have resulted in fractional measurements, much harder to note and remember than these.

CHAPTER LVIII.

CONCLUSION.

The hydraulic press serves best for die-work—that is, the forging of pieces in closed dies, and for the working of plates of iron or of steel; it is equally useful in drawing out and forging steel ingots, but for drawing out iron and for working up ingots of iron from scrap—fagoting as it is technically called—it should be absolutely rejected, because the sharp blow of the hammer is preferable to the uniform and more moderate pressure of the press; the quick blow is necessary to clear the surfaces to be welded from the slag or cinder which protects them from oxidation during the heating, and to secure the successive welding of the different layers of the pile.

The hammer permits forging pieces of large dimensions, such as stern-posts or rudders of ships and anchors, which cannot be handled under the press on account of the narrow space between the supporting columns.

We can always with a hammer, even of very great power, forge small pieces by simply reducing the stroke of the hammer and varying the dimensions of the hammer-head.

To speak in conclusion of local conditions, the valley of the Loire, and Rive-de-Gier in particular, have become the center of the most important forging industry of France. The forges of Petin-Gaudet, Arbel, Barrouin, Marrel Freres, Lacombe and others have made remarkable progress in this industry, in the same way as Brunon has done with work with the hydraulic press.

We have reached in France the point where the steam-hammer is most admirably managed, and where the smith uses his hammer to make the most delicate and the most difficult pieces.

It is sufficient for that purpose, as we have already said, to know how to proportion the intensity of the shock and the effect to be produced, and not to pass too abruptly from one form to another, but on the contrary to arrive gradually and almost insensibly and by successive heats to the form desired without injuring the structure of the metal. This it is which makes the art of the smith both slow and difficult to learn, and which proves once more the truth of the old proverb:

"It is by hammering that one becomes a Smith."

Table I.—Hammers of Less than 10 Tons.

	Place where used.	Builder of Hammer.	Single or Double Acting.	Weight of Working Parts.	Stroke of Hammer.	Diameter of Cylinder.	Kind of Valve used.	Diameter of Piston-rod.	Metal of Frame.	Total Weight of Anvil-block.	No. of Pieces.	Area of Base of Anvil-block.	Ratio of Weight of Hammer to Weight of Anvil.	Remarks.
				Kilogs.	Meters.	Meters.		Meters.		Kilogs.		Sq. m.		
1	St. Nazaire.	L'Horme.	Single.	500	1.200	0.200	Slide.	0.045	Cast-iron.	3,500	1	1.50	1:7	A
2	Ouvion.	L'Horme.	Single.	600	1.200	0.250	Slide.	0.045	Cast-iron.	4,800	1	2.00	1:8	A
3	Firminy.	L'Horme.	Single.	800	1.200	0.290	Slide.	0.080	Cast-iron.	5,200	1	2.00	1:6.5	A
4	Marseilles.	Forges & Chantiers.	Single.	1,000	1.000	0.315	Slide.	0.075	Cast-iron.	7,000	1	2.10	1:7	A
5	Marseilles.	Brunon.	Single.	1,000	1.000	0.320	Slide.	0.065	Cast-iron.	4,500	1	1.50	1:4.5	A
6	Marseilles.	Forges & Chantiers.	Single.	1,200	1.100	0.350	Slide.	0.075	Cast-iron.	6,000	1	1.60	1:5	A
7	Merardiere.	L'Horme.	Single.	1,200	1.200	0.330	Slide.	0.080	Cast-iron.	8,500	1	3.12	1:7	A
8	Izieux.	L'Horme.	Single.	1,500	1.500	0.360	Slide.	0.065	Cast-iron.	6,000	1	2.80	1:4	A
9	Marseilles.	Forges & Chantiers.	Single.	1,800	1.500	0.450	Slide.	0.095	Cast-iron.	6,000	1	2.00	1:3.3	B
10	Marseilles.	Forges & Chantiers.	Single.	2,000	1.500	0.450	Slide.	0.095	Cast-iron.	8,000	1	2.50	1:4	A
11	Marseilles.	Forges & Chantiers.	Single.	2,000	1.550	0.450	Slide.	0.050	Cast-iron.	14,000	1	3.06	1:7	A
12	Lorette.	L'Horme.	Single.	2,000	1.600	0.420	Slide.	0.080	Cast-iron.	10,000	1	3.18	1:5	A
13	Rive-de-Gier.	Brunon.	Single.	2,500	1.650	0.450	Double-seat.	0.090	Cast-iron.	15,000	1	2.80	1:6	A
14	Couzon.	L'Horme.	Single.	2,500	1.500	0.450	Double-seat.	0.090	Cast-iron.	10,000	1	3.20	1:4	A
15	Pompey.	L'Horme.	Single.	2,500	1.700	0.450	Slide.	0.100	Cast-iron.	12,000	1	3.25	1:4.8	A
16	Couzon.	L'Horme.	Single.	3,000	1.600	0.500	Slide.	0.120	Wro't-iron.	14,000	1	4.50	1:4.7	A
17	St. Nazaire.	L'Horme.	Single.	3,000	2.000	0.500	Circular-bal'd.	0.120	Cast-iron.	12,000	1	4.20	1:4	A
18	Marseilles.	Forges & Chantiers.	Single.	3,000	2.050	0.470	Slide.	0.110	Cast-iron.	27,365	1	4.46	1:9	A
19	Turin.	Bietrix.	Single.	3,500	2.000	0.500	Double-seat.	0.110	Cast-iron.	17,000	1	5.00	1:4.8	A
20	Niederbronn.	L'Horme.	Single.	3,500	2.000	0.550	Circular-bal'd.	0.140	Cast-iron.	15,000	1	4.20	1:4.3	A
21	Besseges.	Besseges.	Single.	4,000	2.500	0.650	Double-seat.	0.115	Cast-iron.	22,000	1	5.80	1:5.5	A
22	Firminy.	L'Horme.	Single.	4,000	2.000	0.600	Circular-bal'd.	0.160	Cast-iron.	40,000	1	6.30	1:10	A
23	Marseilles.	Forges & Chantiers.	Single.	4,000	1.800	0.550	Double-seat.	0.120	Cast-iron.	17,000	1	5.00	1:4.2	A
24	Creusot.	Creusot.	Single.	4,000	2.000	0.600	Double-seat.	0.125	Cast-iron.	21,500	1	5.00	1:5.3	A
25	St. Julien.	L'Horme.	Single.	5,000	2.200	0.650	Double-seat.	0.120	Cast-iron.	25,000	1	8.00	1:5	A
26	Guerigny.	Fives-Lille.	Single.	5,000	2.000	0.600	Double-seat.	0.150	Wro't-iron.	35,000	1	7.00	1:7	B
27	St. Étienne.	Bietrix.	Single.	5,000	2.000	0.500	Double-seat.	0.125	Cast-iron.	21,000	1	6.00	1:4.2	A
28	Chambon.	Bietrix.	Single.	5,500	2.000	0.600	Double-seat.	0.130	Cast-iron.	22,000	1	6.00	1:4	A
29	St. Étienne.	Bietrix.	Single.	6,000	2.000	0.600	Double-seat.	0.145	Cast-iron.	30,000	1	6.00	1:5	B
30	Creusot.	Creusot.	Single.	6,000	2.300	0.680	Double-seat.	0.140	Cast-iron.	35,000	1	7.00	1:5.8	A
31	Creusot.	Creusot.	Single.	6,000	2.300	0.700	Double-seat.	0.200	Cast-iron.	60,000	1	7.50	1:10	B
32	Creusot.	Creusot.	Single.	8,000	2.600	0.750	Double-seat.	0.160	Cast-iron.	45,000	1	9.00	1:5.6	A
33	St. Étienne.	Thwaites.	Double.	8,000	1.500	0.700	Circular-bal'd.	0.150	Wro't-iron.	40,000	2	9.00	1:5	B
34	Terrenoire.	L'Horme.	Single.	8,000	2.200	0.730	Circular-bal'd.	0.150	Cast-iron.	40,000	1	7.60	1:5	A
35	Firminy.	L'Horme.	Single.	8,000	2.500	0.850	Double-seat.	0.160	Cast-iron.	40,000	1	9.50	1:5	A

A. Frame rests on anvil-base. B. Independent anvil-block.

Table II.—Hammers of 10 Tons and Over.

	Place where used.	Builder of Hammer.	Single or Double Acting.	Weight of Working Parts.	Stroke of Hammer.	Diameter of Cylinder.	Kind of Valve used.	Diameter of Piston-rod.	Metal of Frame.	Total Weight of Anvil-block.	No. of Pieces.	Area of Base of Anvil-block.	Ratio of Weight of Hammer to Weight of Anvil.	Remarks.
				Kilogs.	Meters.	Meters.		Meters.		Kilogs.		Sq. m.		
35	Marseilles.	Forges & Chantiers.	Single.	10,000	2.200	0.830	Slide.	0.150	Cast-iron.	32,000	1	8.00	1:3.2	A
37	Marine.	Acieries.	Single.	10,000	3.000	0.870	Double-seat.	0.160	Wro't-iron.	55,000	1	7.50	1:5.5	A
38	Firminy.	L'Horme.	Single.	10,000	3.000	0.900	Circular-bal'd.	0.250	Cast-iron.	40,000	1	5.50	1:4	B
39	Niederbronn.	L'Horme.	Single.	10,000	3.200	0.850	Double-seat.	0.150	Cast-iron.	60,000	3	3.10	1:6	A
40	Couzon.	L'Horme.	Single.	10,000	1.600	0.850	Double-seat.	0.160	Wro't-iron.	40,000	2	7.30	1:4	B
41	Rive-de-Gier.	L'Horme.	Single.	12,000	2.200	0.900	Circular-bal'd.	0.180	Cast-iron.	41,000	1	8.20	1:2.9	A
42	Guerigny.	Creusot.	Single.	12,000	3.000	0.880	Double-seat.	0.196	Cast-iron.	90,000	4	13.00	1:7.5	A
43	Creusot.	Creusot.	Single.	15,000	2.850	0.950	Double-seat.	0.220	Cast-iron.	110,000	2	15.00	1:7.3	A
44	Lorette.	Bietrix.	Single.	15,000	1.600	0.820	Circular-bal'd.	0.180	Wro't-iron.	65,000	1	7.50	1:4.3	B
45	St. Étienne.	Acieries.	Single.	15,000	3.000	0.900	Double-seat.	0.190	Cast-iron.	55,000	1	6.00	1:3.7	B
46	Rive-de-Gier.	L'Horme.	Single.	20,000	3.000	1.100	Double-seat.	0.190	Cast-iron.	60,000	3	13.20	1:3	A
47	Guerigny.	Creusot.	Single.	20,000	3.000	1.450	Double-seat.	0.2[illegible]0	Cast-iron.	185,000	7	9.50	1:9.2	B
48	Couzon.	L'Horme.	Single.	20,000	1.600	1.000	Double-seat.	0.180	Wro't-iron.	60,000	2	8.20	1:3	B
49	Creusot.	Creusot.	Single.	20,000	2.850	0.950	Double-seat.	0.220	Cast-iron.	140,900	2	14.80	1:7	A
50	Sheffield.	Thwaites.	Double.	20,000	3.048	1.068	Circular-bal'd.	0.203	Wro't-iron.	203,210	5	21.00	1:10	B
51	Firminy.	L'Horme.	Single.	25,000	3.000	1.250	Double-seat.	0.220	Cast-iron.	100,000	2	12.30	1:4	B
52	Lorette.	Bietrix.	Single.	25,000	1.600	1.050	Circular-bal'd.	0.220	Wro't-iron.	95,000	1	11.00	1:3.8	B
53	Marine.	Acieries.	Single.	28,000	3.500	1.200	Double-seat.	0.210	Cast-iron.	75,000	1	13.00	1:3.6	A
54	Rive-de-Gier.	L'Horme.	Single.	30,000	2.000	1.320	Circular-bal'd.	0.220	Wood.	60,000	1	9.00	1:2	B
55	Elswick.	Thwaites.	Double.	30,000	3.660	1.200	Circular-bal'd.	0.2[illegible]4	Cast-iron.	304,000	4	16.00	1:10	B
56	Woolwich.	Nasmyth.	Double.	35,000	3.400	1.370	Circular-bal'd.	0.250	Cast-iron.	587,000	6	30.00	1:16	B
57	Marine.	Acieries.	Single.	35,000	3.500	1.350	Double-seat.	0.250	Cast-iron.	125,000	1	20.00	1:3.6	A
58	Couzon.	L'Horme.	Single.	40,000	1.600	1.320	Circular-bal'd.	0.240	Wro't-iron.	140,000	3	12.00	1:3.5	B
59	Creusot.	Creusot.	Single.	40,000	3.250	1.200	Double-seat.	0.250	Cast-iron.	210,000	3	17.80	1:5.3	A
60	Rive-de-Gier.	L'Horme.	Single.	50,00[illegible]	4.0[illegible]0	1.480	Circular-bal'd.	0.260	Cast-iron.	250,000	4	14.40	1:5	A
61	Alexandrowski.	Thwaites.	Single.	50,000	3.800	2.000	Circular.	0.260	Cast-iron.	240,000	3	......	1:4.8	B
62	Obookoff.	Thwaites.	Double.	50,000	4.572	1.981	Circular-bal'd.	0.305	Cast-iron.	508,485	8	48.00	1:10	B
63	Marine.	Acieries.	Single.	80,000	4.800	1.900	Double-seat.	0.340	Cast-iron.	500,000	5	25.00	1:6.3	B
64	Creusot.	Creusot.	Single.	100,000	5.000	1.900	Double-seat.	0.420	Cast-iron.	750,000	11	33.00	1:7.5	B
65	Terni.	Cockerill.	Single.	100,000	5.000	1.920	Double-seat.	0.360	Wro't-iron.	1,000,000	1	42.00	1:10	B
66	Rive-de-Gier.	Marrel Frères.	Single.	100,000	5.100	2.000	Circular-bal'd.	0.370	Wro't-iron.	500,000	7	28.62	1:5	B

A. Frame rests on anvil-base. B. Independent anvil-block.

NATIVE INDIAN SUSPENSION BRIDGES.

(From the *Indian Engineering*.)

THERE are still many good samples of primitive native suspension bridges in the Darjeeling District of Bengal. One of the largest and most characteristic of these structures is swung over a mountain torrent 300 ft. wide, at a height of 70 ft. above low-water level ; this will give some idea of the size to which these bridges sometimes extend.

These structures are constructed of cane and bamboo, and their lightness and extreme simplicity are very remarkable. The cables are made from a species of rattan. They are from one to two inches in thickness and 20 or 30 yards long, knotted together, and the other pieces are fastened to them by strips of the same plant. The flooring is of bamboo, consisting of stems laid longitudinally, supported by cross pieces hung from the two upper cables, which also serve the additional purpose of keeping the latter apart. When properly constructed and strongly made, these bridges are easy to cross. A Lepcha, carrying 140 lbs. on his back crosses without hesitation, slowly but steadily, and with perfect confidence.

Hooker in his Himalayan Journals considers these Julungas, or cane bridges, characteristic objects of Himalayan art. He furnishes an illustration and description of them, and we are indebted to him for some of the particulars here furnished. But perhaps the best technical information in brief on this subject is that afforded by Major Sherwill. He says :

" The main chains supporting the bridge are composed of five rattan canes each ; the sides are of split cane hanging from each main chain as loops, two feet apart, and two feet deep. Into these loops the platform is laid, composed of three bamboos, the size of a man's arm, laid side by side, the section of the bridge resembling the letter V, in the angle or base of which the traveler finds footing. Outriggers, to prevent the main chains being brought together with the weight of the passenger, are placed at every 10 or 12 ft. in the following manner : Under the platform and parallel to the stream strong bamboos are passed, and from their extremities to the main chain (of cane) split rattan ropes are firmly tied. This prevents the hanging loop or bridge from shutting up and choking the passenger. The piers of these bridges (for there are several of them) are generally two convenient trees, through whose branches the main chains are passed and pegged into the ground on the opposite side."

DRAINAGE OF THE VALLEY OF MEXICO.

THE project for the drainage of the valley of Mexico, which has been under consideration for a number of years, is now in a fair way to be at last carried out ; a contract having been let to the firm of Read & Campbell, of London, for the tunnel and other works needed to complete it.

As is well known, the city of Mexico is situated in a valley, which, although it has an altitude of over 7,000 ft. above sea-level, is surrounded by still more lofty mountains and has no natural outlet. The area of the valley is about 1,650 square miles and a considerable part of it is occupied by six lakes, on the banks of one of which, Lake Texcoco, the city of Mexico is built. This lake is the lowest of all the six and would naturally receive their drainage, were it not for the artificial restraints which have been adopted to prevent their overflow, and resulting injury to the city.

The first attempt to drain the valley was made as long ago as 1604, and some 20 years later a tunnel was cut through the mountain wall by which a portion of the surplus waters was carried off, but 30 years afterward the constant trouble with this tunnel induced the Government of that time to convert it into an open cut. This work took nearly 150 years to complete, but it finally assumed its present form. The cut of Nochistongo, as it is called, is 13 miles long, about 360 ft. wide, and in some places over 200 ft. deep. It served its purpose as an outlet for some of the lakes during the rainy season when the surplus water in the valley exceeded that removed by evaporation.

In 1856 there was first suggested the plan for draining the lakes of the valley—and especially Lake Texcoco—by a tunnel, which would so reduce their level as to remove all danger of overflow water caused by an unusual rainfall, and would at the same time serve to carry off the sewage of the city, which is now discharged into Lake Texcoco, and which causes a great deal of trouble in high water. The plan adopted at that time was devised by Don Francisco Garay, but its execution was delayed by political troubles, and although some work was done in 1866, nothing was completed.

Lately a new project was adopted by which the lake was to be controlled by securing so low a level that continued rains would not raise it sufficiently to flood the city, or to back up the sewage. Under this plan it is estimated that the volume of water to be disposed of during the five rainy months is 196,000,000 cubic meters, requiring an approximate discharge of 15 cubic meters per second.

The canal, which constitutes the principal feature of this plan, is divided into two parts. The first section, which is 12.4 miles in length, has to carry water from the lake to the city of Mexico only. The second section, which is to have nearly three times the capacity of the first, has to carry the surplus water of the lake and the discharge from the city ; this section is 17.4 miles in length and 21 ft. deep. The flow of the lake water into the canal will be controlled by gates, and the fall for the whole length is 1:5,000. The most important part of the works, however, is the tunnel, which will commence at the end of the canal and extend through the mountains for a distance of 9,520 meters (5.9 miles), with a deep cutting about 500 meters (1 640 ft.) in length at the outer end. The fall through the tunnel is 1 : 1,000 and its cross-section will be semi-ovoid—that is, of the form which has been adopted for large sewers, as giving the lowest resistance and as best adapted for a variable flow of water. The upper, or arch part of this tunnel will be lined with brick and the lower part with stone and cement. Much of the work which was done over 20 years ago can be utilized in the construction of this canal. This includes the sinking of 24 shafts and the excavation of about 1,000 meters in length. The shafts are about 400 meters apart, and the deepest is about 100 meters in depth. The new contractors propose to work both ways from each of the 24 shafts, and in so doing

they will have to provide an extensive pumping plant to dispose of the water met with in excavation, in addition to the hoisting and other engines required for the work. Each shaft will have two engines, one for pumping, the other for hoisting and ventilation, which will be effected by means of Root blowers. The contractors will also establish extensive yards for making the bricks required for lining the tunnel and kilns for burning the lime, from lime-stone obtained in the neighborhood. There will also be an electric light plant for lighting the tunnel during the progress of the work.

This very important and interesting engineering work will be carried on entirely under English direction. Native labor will, of course, be employed, but under the management of English foremen and engineers. The general features of the valley and of the country through which the canal and tunnel pass are shown by the small map printed herewith.

A FRENCH ENGINEER ON AMERICAN BRIDGES.

(M. Le Rond in the *Annales des Ponts et Chaussées.*)

THE construction of metallic bridges has made great progress since the publication of the work of MM. Lavoinne and Pontzen, both in relation to the system of bridges and the method of execution and in the nature and quality of the material used. Works daring in their design and of a kind entirely new have enabled us to cross in an admirable and comparatively inexpensive way ravines and rivers, which had heretofore defied the engineer, and steel has almost entirely replaced iron in bridge construction.

For a description of the earlier American bridges the engineer may consult with advantage the works of Malezieux and of Lavoinne and Pontzen. We propose here to give a short summary of the actual state of the art of bridge construction in America.

We will pass by entirely wooden bridges, although the railroad lines still use, especially in the Far West, many wooden bridges, often of considerable span ; thus, for instance, at Albany, over the Willamette River, there is a Howe truss draw of 260 ft. span.

Generally speaking American bridges may be divided into four principal types :

1. Girder or Truss bridges.
2. Suspension bridges.
3. Arch bridges.
4. Cantilever bridges.

Of these four classes of bridges we will speak separately.

I. GIRDER OR TRUSS BRIDGES.

These bridges are the true American type of bridge and include the greater part of the works yearly constructed in that country.

They consist of members composed of simple elements, divided into chords, posts, and ties, each member being usually exposed to only a single kind of strain, compression, or tension, to the exclusion of all bending moment, and held together by pins.

The trusses, in which the parts are called upon to resist only a single kind of strain, include also counter-ties, which are only called upon to support a strain in certain unsymmetrical conditions of the load.

Bridge trusses may be divided into three classes: Simple, Multiple, and Complex.

A Simple Truss may be divided into a system of triangles, each having one side common with the adjoining one ; an example of this is the Pratt truss, figs. 1 and 6.

A Multiple Truss may be decomposed into several simple trusses, the chords of which coincide ; an example being the Linville, fig. 2.

A Complex Truss is a simple truss in which the effective bearing of the panels is reduced by constructing on these panels as a base a secondary truss ; an example will be found in the Pettit truss, fig. 3.

The simple trusses most generally in use are the Warren, or triangular truss, fig. 4, and the Pratt truss, fig. 1.

The multiple trusses most used are the Linville truss and the multiple Warren truss. Linville trusses have been made triple and even quadruple, but the double is now the only one in use. In the same way the double triangular is the only one in use in truss bridges. Generally the points of crossing of the two systems (fig. 5) are used as points of suspension for the bridge floor, which reduces by one-half the length of the panels. The quadruple triangular system has been used in the construction of several riveted bridges.

The complex truss most used is the Pettit system. The Union Bridge Company also uses several complex systems, derived from the simple triangular system.

Multiple trusses, and especially the Linville truss, have been for some time the only ones used for large spans. Among these we may mention here the span of 520 ft. on the Cincinnati Southern Bridge over the Ohio, built by the Keystone Bridge Company, under the direction of Mr. Bouscaren ; the steel bridges at Plattsmouth and Bismarck, each having three 400 ft. spans, and the Blair Bridge, also over the Missouri ; these three bridges were designed and built by Mr. Morison, one of the engineers who has built most during the last few years. There may be mentioned also the Randolph Bridge over the Missouri, having three spans of 400 ft. each in steel, built by Mr. Strobel under the direction of Mr. Don J. Whittemore.

Nevertheless many engineers are giving up the multiple systems in favor of the simple and complex trusses. Reason and experience alike have shown that it was incorrect in practice to consider multiple girders as formed of simple girders working separately without interfering with each other, and that the calculation of strains under this hypothesis is always subject to doubt. In simple or complex girders, on the other hand, the strains can be ascertained by calculation with great exactness. Moreover, a number of important works have been built in recent years on the Pettit system—the Cincinnati & Covington Bridge, over the Ohio—or even on the Warren system—the Henderson Bridge, over the Ohio, with a channel span of 522 ft.—or the Pratt system—the bridge over the Hawkesbury River, New South Wales, with seven spans of 408 and 416 ft. The application of a simple system to long spans is something entirely new in American construction, and it is marked by a tendency to substitute long panels for the short panels of the old systems.

Simplicity of construction and the advantage of having in a span only a single form and a single length for all similar parts, the cross-section alone varying, long since caused American engineers to give up the slight economy allowed by making the trusses of a variable height.

It may be said, however, that broken or jointed chords have entered into practice for some years past, and are now frequently employed in small Pratt trusses, in the form of an inverted bow-string (fig. 6), and in large spans of the Pratt and Pettit types. Instances are found in the Van Buren Bridge, the Sault Ste. Marie, the Cincinnati & Covington, and the Hawkesbury River bridges. There has even been built, at Pittsburgh, in 1883, a bridge of the bow-string type, recalling the bridge over the Rhine at Mayence, and Mr. Bouscaren has built, in 1886, a bow-string cantilever over the Licking River at Newport.

American truss bridges are always pin-jointed, although some companies, like the Union Bridge Company, have built riveted truss bridges ; for instance, one of the quadruple-triangular system, of 187 ft. span, over the Hudson River at Troy. But we cannot from this conclude that the Americans are giving up the pin-joint for the riveted construction ; in fact, the example which we have just cited remains a solitary one, and this work has been done only by a single company, which is remarkable in recent years for the efforts which it has made to improve construction, and by the attention which it has given to the building of large cantilever bridges. Aside from this exceptional example the span of riveted girders is generally limited to 100 ft. Below that limit the pin-jointed trusses are too light and offer too little resistance to accidents, such as derailments, and plain riveted girders are generally used, but all the bridges of medium and of large span are built on the pin-joint system.

Far from giving up this system, American engineers have entirely abandoned in their construction certain old

arrangements, such as the sleeve-joints formerly used by the Phœnix Bridge Company, or the riveted joints used in the Cincinnati Bridge or the Kentucky River viaduct, and specifications always require that all the joints should be pin-connected.

The principal objection which American engineers make to riveting is, that it cannot be well done in the shops. For this reason they limit as much as possible connections of this kind in their works, and take care generally to put upon rivets, driven in place, only a sort of passive work, requiring them to keep the assembled pieces in their respective positions only, and not to transmit any strain from one to the other.

The counter-bracing of American trusses is ordinarily pin-jointed also, and is composed of compression members, which are at once special parts and ordinary members of the structure, and are generally crossed and joined together by adjustable fastenings. The flexibility resulting from this arrangement, however, has some inconveniences, and in recent works an application of riveting more or less extensive has been made to the counter-bracing, as will be found in the Omaha, the Randolph, the Poughkeepsie, and other bridges.

The floor-system of American bridges is generally composed of beams or girders supported directly by the pins or bolts of the truss, and joined together by longitudinal girders which carry the road. The road, or track, is laid upon cross-ties, or in exceptional cases upon longitudinal sleepers. The floor in American bridges is only subjected to bending strains ; it rests upon fixed points, being either carried upon the upper chord in deck bridges or suspended from the lower chord in through bridges.

In many new works the floor-system and the counter-bracing only are of iron, the rest of the bridge being of steel.

It may be said in a general way that in late years American engineers have sought less to create new types than to eliminate the imperfect or complicated types formerly used, and to perfect the parts and the methods of construction of their favorite types. The study of the progress realized in this direction is very interesting and instructive, but the limits of the present article do not permit us here to enter fully into the developments, which must be reserved for a more detailed study.

2. SUSPENSION BRIDGES.

America possesses the largest and, it may be said, the best suspension bridges. The works of this class have been built with very great care, and the systems employed have been such that they could be applied without danger to the longest spans and the heaviest rolling loads. We have not here space for any full description of these works, accounts of which may be found elsewhere. These bridges may be divided into two principal classes :

1. Suspension bridges with a rigid floor and inclined wires or ropes, which include the largest and the finest bridges, such as the Suspension Bridge at Niagara Falls, 823 ft. span, the Cincinnati Bridge, and the Brooklyn Bridge, 1,600 ft. span.

2. Suspension bridges with a rigid cable, of which there are two examples at Pittsburgh ; one over the Allegheny, with parallel cables united by triangular bracing, and the other known as the Point Bridge, over the Monongahela River.

Suspension bridges are theoretically more economical than trusses, but the advantage, very light when we speak of American trusses, disappears in the execution, in consequence of the greater quantity of hand-work required in suspension bridges and the high cost of that kind of work in America. Thus, no important works of this kind have been undertaken since the Brooklyn Bridge, but a well-known engineer, Mr. Lindenthal, has recently proposed to build a suspension bridge carrying six tracks, which will cross the Hudson River with a single span of 2,850 ft., resting upon steel towers 600 ft. in height. This bridge, which would include also two shore spans of 1,390 ft. each, would have both rigid cables and a rigid floor system.

Nevertheless, since the invention of the cantilever system, in spite of the advantageous work of metal in suspension bridges, the era of those bridges seems to be at an end, and Mr. Lindenthal's project seems to be far from execution.

3. ARCH BRIDGES.

The fine arch bridge over the Mississippi at St. Louis, has remained for a long time without imitation in America. The reason is, that with these, as with suspension bridges, the expense of construction is considered too great.

This year, however, a very fine arch bridge, known as the Manhattan Bridge, and having two spans of 510 ft. each, has been built over the Harlem River, in the suburbs of New York. This bridge is built upon centers and has riveted counter-bracing. The arches are full, like those of Nantes, and carry the floor by means of columns, which are counter-braced only in a transverse direction.

This elegant system is not without its inconveniences in a work of the size of the St. Louis Bridge. This bridge carries a very heavy railroad traffic, and, in consequence, doubtless of the vibrations inevitable in this system, the

Fig. 1.

Fig. 5

Fig. 2.

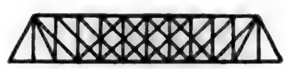


Fig. 6.

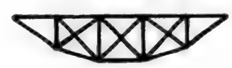
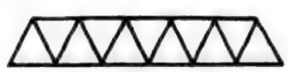


Fig. 3

Fig. 7

Fig. 8.

Fig. 4.



rails of each track creep about 2 ft. a day, in the direction in which trains travel and no method has yet been found to stop this creeping. It may be noted, however, that the floor of the St. Louis Bridge has been recently entirely rebuilt, and at this writing the results have not been reported.

4. CANTILEVER BRIDGES.

The invention of cantilever bridges has been the greatest step in advance realized in America in the art of construction. These remarkable works have not generally the elegance of an arch bridge, but they have definitely solved the question of the construction of bridges of very large span. The building of the great suspension bridges and of the arch bridge at St. Louis, had proved that the economical solution of the problem did not lie in those systems. The complete solution, from both a practical and economical point of view, was for the first time furnished by the building of the Kentucky River Bridge, by Mr. Shaler Smith.

In this bridge the central span extends beyond the supporting points and carries the lateral spans, as shown in the small diagram, fig. 7. In the bridge built by Mr. Schneider at Niagara Falls, on the other hand, the lateral spans are extended beyond the points of support and carry the central span. This modification is shown in the small diagram, fig. 8.

In both types the free suspension of the central span is secured by a special arrangement, which can be reduced

strictly to a pin-joint on one of the chords and a sliding-joint on the other. The sliding-joint in both cases is shown at *a a*, figs. 7 and 8.

The first type is represented by the Kentucky River Bridge and by the Minnehaha Bridge, of Mr. Shaler Smith, and by a plan for a great cantilever bridge, which was prepared by Mr. Bouscaren, for the Cincinnati & Covington Bridge, but which was not carried out, having been replaced by a work with separate spans. The second type finds examples in the Niagara Bridge; the Frazer River Bridge, on the Canadian Pacific, also by Mr. Schneider; the St. John Bridge, by the Dominion Bridge Company; the Kentucky & Indiana Bridge at Louisville, and the Poughkeepsie Bridge, by the Union Bridge Company.

To this type also belongs the Lachine Bridge, having two cantilever spans of 400 ft., and a total length of 3,520 ft., built over the St. Lawrence River, for the Canadian Pacific Railroad, by the Dominion Bridge Company, from the designs of Mr. Shaler Smith. In this bridge, perhaps the finest of its class, which consists of two connected cantilever spans, the suspended span does not exist, and the two cantilever arms being joined, the bridge in reality, forms a continuous girder carried upon five supports. Alone among all the bridges of its class so far built, it has the two cantilevers joined in this manner, which requires a symmetrical construction and balancing upon the central pier.

Cantilever bridges have a double origin, first practical and then theoretical. The idea of the cantilever construction dates back evidently to the St. Louis Bridge, but the construction of that work, without the ordinary false-work, required the construction of immense wooden towers, to carry the suspending cables used until the arch was completed, and the Kentucky River Bridge was the first built without any intermediate supports.

In a theoretical point of view cantilever bridges are continuous girders carried on four supports and jointed at two places in their span. They are, then: 1. So far as they are continuous girders, lighter than bridges of separate spans. 2. Lighter than ordinary continuous girders, from the fact that the bending moment is nothing at the points of suspension, for any distribution of weight which may be made, and that the position of these points can be chosen in such a way as to secure a maximum economy.

The complete theory of the cantilever system involves other considerations, which we hope hereafter to develop in a detailed study of the type, and for which there is not room in this paper. We must limit ourselves to the few following statements, which will be sufficient to establish the superiority of the American system in general and of the cantilever system in particular over the European systems, both from the point of view of rapidity and ease of construction and from that of economy.

Bridges with separate spans are erected on false-work; for the largest spans this operation takes at most one or two weeks. The Union Bridge Company erected, in *three days*, a span of 260 ft. in the bridge over the Arkansas, at Van Buren.

In the cantilever bridges the counter-weight span is erected on false-work, but the cantilever span without supports, the trusses sustaining themselves.

The Kentucky River Bridge, composed of three spans of 375 ft., was built over a ravine 280 ft. deep, without any false-work except a wooden pier to support the center of the bank-spans, the whole work taking 116 days. The metallic part of the Niagara Falls Bridge, which includes two lateral spans of 108 ft., and a central span of 495 ft. resting upon metallic towers nearly 200 ft. in height, was built between August 29 and November 22, 1883. The bank-spans were erected on false-work and the central spans without supports.

The Kentucky River Bridge, which is of iron and carries a single track, had in all in the structure 1,642 tons of metal, of which 1,283 tons were in the trusses and 359 tons in the iron towers. According to Mr. Lindenthal, three spans of the ordinary type would have weighed 1,579 tons for the superstructure alone, or 286 tons more than the actual weight of the bridge. The cantilever system in this work may thus be credited with a saving of about 18 per cent in metal over the ordinary American system. If, now, we compare it with the average weights of European bridges, taking as a standard the tables given by Inspector-General Croizette-Desnoyers, a riveted girder of the European type of the same span would weigh 5,270 kg. per running meter—that is, 668 kg. more than an ordinary American bridge and 1,570 more than a cantilever bridge.

The cantilever bridge at Niagara Falls, which has a double track and is in part of steel, required altogether 2,035 tons of metal, of which 1,670 tons are in the superstructure. The proportion of steel used is about one-quarter. Three separate spans of the American pattern and of the same length, with the same proportion of steel, would have required 2,009 tons for the superstructure, so that the economy of the cantilever system in this case was about 17 per cent. If we compare these weights with that of a European bridge of the same span, we find that such a bridge would have required 2,700 tons of metal, if all of iron, or 2,200 tons if one-quarter of steel.

From this example we find that the saving in material of the ordinary American bridge over the European system is about 10 per cent., while with the cantilever the saving would be about 24 per cent.

It is true that pin-jointed and especially cantilever bridges show greater deflection under the passage of a rolling load than riveted bridges, but this deflection would not present any serious inconveniences except for the passage of trains at a very high speed, and it is always easy to avoid them by a careful study of designs. They do not constitute by any means a vice inherent to the American system.

It is, perhaps, useless here to enter at any length into the old discussion of the relative merits of pin-jointed and riveted bridges. It is, perhaps, best to conclude with a distinguished American engineer, that the final decision will come to a point between that now claimed by the extreme advocates of both systems, and that the final solution will be a mixed one.

In fact, it is toward this mixed solution that American practice is now tending, by the adoption:

1. Of riveted girders for small spans, the limit at which it is best to cease applying this system being not yet definitely fixed, but perhaps generally taken at about 100 ft.
2. Of pin-jointed spans in all other cases.
3. Of riveted counter-bracing in pin-jointed bridges of large dimension.

CONCLUSION.

From this study, and from the examples which we have given and which could easily be multiplied, it follows that the American methods of construction have a certain number of incontestable advantages over the methods pursued in Europe.

1. In American bridges, even of the multiple system, the strains are much more exactly defined than in any riveted system, and in the bridges of the simple system the knowledge of the strains is absolutely certain.
2. The construction of these works is much more simple and more rapid than that of European bridges.
3. The cantilever system permits us to span large openings at any height whatever, and works built on this system are not exposed to accidents, such as happened at the Tardes Viaduct and which are always to be feared when it is necessary, as in that case, to launch a completed span upon the piers. Moreover, the use of the pin-joint construction permits the execution of these works with astonishing rapidity. The Forth Bridge, where the English have applied the cantilever system, and which, under construction for several years, is still far from completion, could have been built in much less time on the pin-joint system.
4. Finally, the different American systems realize a saving of from 10 to 30 per cent. over our bridges in weight, and the saving in hand-labor is still greater.

It remains for us to prove that these advantages are not counterbalanced by a want of rigidity, by an excess of strain imposed upon the metal beyond the limits allowed by us, nor by increased difficulty of cost of maintenance. To answer these criticisms it is necessary to study in detail:

1. The principles applied to the use of metal in Ameri-

can bridges. 2. The form given to the members according to their work and the method of assembling the parts. 3. The method of construction of the different members of the metallic trusses, the nature and quality of the metal employed, according to the parts in which it is used, the work to which they are submitted in the shops and the tests made of them both before and after they are put into their final form.

Such a study is necessary to justify the adoption of the pin-joint construction, since there is always a difference between theory and practice, and to undertake an important work on this system without profiting by the long experience of American engineers, would be to invite almost certainly some of the accidents which happened when this kind of construction was first adopted. To prove this we may give a single example. At the Bismarck Bridge, a very remarkable work, which we have already had occasion to mention, the order of two eye-bars meeting at the central pin was reversed by a mistake; although the reciprocal displacement of each of these bars amounted to hardly 3 cm., there resulted a strain of 21 kg. per square millimeter on the pin.

Pin-jointed bridges will not permit any carelessness or even mediocrity in the execution of the work, although it may pass in a riveted bridge.

HYDROGRAPHY AND HYDROGRAPHIC SURVEYS.

By Lieutenant Henry H. Barroll, U.S.N.

(*Continued from page 372.*)

V.—THE WINDS.

An important question to mariners is, of course, that of the winds; for while the increase of steam has to some extent rendered seamen less dependent on the winds than before, it is nevertheless true that a very large portion of the world's commerce is still carried in sailing vessels, and even steamers are largely dependent on the winds for favorable passages, so that a few observations on this question may not be out of place.

The general definition of wind is, "Air in motion." If the earth had no rotary motion about its axis, there would be winds only from the north in the northern hemisphere, and from the south in the southern hemisphere.

These would be caused by the airs at the equatorial regions becoming heated, and therefore rarefied, and rising; while the colder air from the polar regions would rush in to fill the space thus left.

The rotation of the earth on its axis, however, acts to change this direction, and the polar currents, approaching the equator from the north and the south poles, are deflected momentarily, and cause the winds to appear to be coming from N.E. and S.E.

These polar currents form what are called the "trade-winds." They are the great arteries in the air circulation of the world, as the great equatorial currents are to the water circulation or as the aorta is to the blood circulation in the human body.

It will be readily seen that with the wind in the northern hemisphere blowing from northeast, and in the southern hemisphere from the southeast, there will be a line or band between the two, where their forces will neutralize each other. This is near the equator, a belt of some 600 miles, and which is called the Region of Calms. In this equatorial belt, as well as in the trade-wind belts, there are frequent disturbances, but the trade-winds speedily recover their comparatively regular force and direction. The trade-winds are not felt at the earth's surface in higher latitudes than about 30°; and they "swing with the sun"—that is, they extend farther north or south, according as the sun is in its northern or southern declination.

These winds, comparatively steady and reliable in strength and direction, have been denominated "trade-winds," from the great assistance which they give to commerce. There are four regions of trade-winds—the Atlantic, Northeast and Southeast trades, and the Pacific, Northeast and Southeast trades; each divided by the equatorial calm belt before referred to.

The knowledge which we now possess of the trade-winds enables us, unerringly, to place upon each monthly issue of the North Atlantic Pilot Chart the line showing the "sailing route from Europe to America, by way of the trades," for that month, and the data returned each succeeding year, from vessels following these routes, adds to the exactness of future predictions.

The winds are divided into three general classes—steady, periodic and variable. The trades are the only winds that can be called steady; and even these, as has been before stated, are at times interrupted and changed in direction by local disturbances.

Periodic winds are those which, while blowing only at certain times during the year, yet during that time blow with a comparatively steady force and direction. To this class belong the monsoons of the Indian Ocean, which blow for about six months in one direction, and the remaining six months in an opposite direction. The harmattan, a warm, dry wind peculiar to the west coast of Africa, blows in series of three, six or nine days. To the class of periodic winds might also be added the general sea and land breezes at night and morning, caused by the radiation from the earth's heated surface.

Variable winds are those which do not, apparently, have any regular cause for their existence, and which do not, apparently, follow any regular course. I say "apparently," because in later years we begin to find that there is a natural cause for every gale that blows, and that in their course they follow laws with regard to force and direction as exact as those of the trade-winds.

The cold, straight current of air sweeping across the Texas plains from the north or northwest is denominated a "norther," while the similar wind, rushing from the south across the "pampas" of the Argentine Republic, is called a "pampero."

The more violent gales are called tornadoes, cyclones and hurricanes. A tornado (from the Spanish "Tornar," to return, to come back again) derives its name from the fact that the wind shifts its direction during the blowing of the gale.

A cyclone is a whirlwind, sometimes 400 or 500 miles in diameter, and with a comparatively calm center, which travels along a parabolic curve from the equator toward the pole—northward or southward, according to the hemisphere in which the gale occurs.

Circular storms are variously denominated cyclones, tornadoes, typhoons or hurricanes. These are but different names for storms of the same character. The typhoon (great wind) of China is identical with the cyclone of the North Atlantic or the ouragan of the Indian Ocean.

A cyclone is a gigantic whirlwind blowing around a comparatively calm center, this center also moving gradually along from the tropics toward the poles.

This center, instead of being a place of safety, is subject to violent and sudden squalls or gusts of wind and high, confused seas.

Its comparative calmness is caused by the enormous inward pressure of those immense air-walls, and is the result of their neutralizing forces.

The rate of speed of the storm center varies. Its motion is always very slow, as compared with the terrible velocity of the air-current whirling about it.

In storms passing along our coast, when the wind will be blowing at the rate of 60 to 100 miles an hour, *or* 1,500 *to* 2,500 *miles a day*, the storm center may move only at the rate of 100 to 120 miles in 24 hours.

The limits of this article will not admit of an extended discussion of the several theories as to the causes of cyclones. I will only say that these hurricanes, rushing from the tropics toward the poles, carry immense volumes of air from the great trade-wind belts, and that this serves to restore equilibrium when local disturbances in the higher latitudes have caused a want of equilibrium.

Until the nature of these storms was understood their effects were terrible, but with a better understanding which we now have, vessels can to a great extent avoid them, or at any rate escape their worst effects.

VI.—OCEAN CURRENTS.

Currents form another question of very great importance to navigators. An ocean current may be defined as a river or stream of water moving on the surface of the sea. There are also other currents underneath the surface, and called submarine currents, but these do not directly affect the motion of vessels. Ocean currents are caused by winds and other influences, but not by tidal influence, which is felt only near the coast.

The limits, direction, and velocity of the several ocean currents have been largely determined by the drift of bottles, which have been thrown overboard for that purpose from vessels, and having securely sealed in them the date and position of the vessel at the time the bottle was put overboard. These being afterward recovered, show by the date and locality in which they were picked up, the strength and direction of the current which has borne them there. Among the blank forms furnished to those merchant vessels which record observations for the Hydrographic Office, is one to be filled out, and placed in the bottles thus thrown overboard. This paper contains the following sentences, printed in English, French, German, Italian, Portuguese and Spanish :

"Ocean Current Report."

"Thrown overboard by (give name of vessel, date and position)."

"Found by (give name of vessel, date and position)."

"Please send this to any United States Consul, or forward it direct to Washington."

These little wanderers go floating about the seas, and the information that they contain is carefully preserved.

Of all the currents of the ocean, probably the best known is the Gulf Stream, in the Atlantic ; this has been the most closely observed, because the commerce of that part of the ocean through which it passes is greater, and the number of vessels whose course is affected by it, is larger than is the case of any other current in the world. The Gulf Stream has its counterpart in the Pacific, in the Kuro Siwo, or great Japanese current, which flows across the Pacific, and which moderates the climate of the Northern American shore of that ocean in the same way that the Gulf Stream does that of Western Europe. Both currents are formed in the first place by the breaking off of the equatorial current striking the American shore of the Atlantic and the Asiatic shore of the Pacific. The knowledge of the force, direction and speed of these currents is of great importance to vessels, much time being often saved by the intelligent use of their assistance.

VII.—TIDES.

The question of tides has engaged much attention from the hydrographer. As is generally known, of course, the tides are the result of the attractive forces of the sun and the moon, the moon having by far the greater influence, owing to its comparative proximity to the earth. In discussing this question care must be taken that the *tidal currents*, or horizontal motion of the waters, be not confounded with the upraising of the sea. There are two entirely distinct phenomena caused by this tidal action. One of these is a perpendicular motion, a *rise* and *fall* of the waters, alternating with more or less regularity. The other is a horizontal motion, or *current*, flowing to and fro, also with more or less regularity. These phenomena are frequently confounded, being collectively spoken of, as "the tide." It has become customary, however, in modern times, to refer to the stream as the "*tidal current*" or "*tidal drift* ;" and to use the word "tide," only when strictly referring to the *change in elevation* or the *rise* and *fall* of the waters.

As both the sun and the moon have an influence upon the tides, this influence is of course greatest when both act in the same line. Therefore, the *highest* high tides and the *lowest* low tides are those occurring at full and at new moon, and are called spring tides.

When the moon is in its first or its third quarter, its attracting force, instead of acting with that of the sun, is acting at right angles to that force ; and the *high* tide caused by the moon will occur at the time of the *low* tide caused by the sun, and *vice versa*. Thus, the *lowest* high tides and the *highest* low tides of the lunar month will occur when the moon is in its first or in its third quarter.

These smallest tides are called neap tides.

It may be noted, however, that the highest tides do not occur at exactly new or full moon, but always a day or two later.

The rate at which the tidal elevation of water is carried westward is very rapid. The motion of the tide-wave can be thus described : Suppose a rope to be held by two persons, at some distance from each other. Now should one of them give this rope a sudden shake, up and down, the wave of this force will be carried along to the other person's hand rapidly ; more rapidly than one person could run to the other, carrying the rope.

It is a *translation of motion ;* while the *tidal current* or *drift* that affects vessels, and which some people call "the tide," is an absolute *transfer of waters* from one place to another.

If the earth's surface were completely covered with water, and we should neglect the slight retardation due to friction, then the tide wave would follow the moon in its course, traveling at the rate of 900 miles an hour, from east to west.

Owing, however, to the retarding influences of shoals, islands and the coasts of the continents themselves, the velocity of the tide-wave is much diminished. It, however, travels at a much greater speed than any tidal current. The tide easily travels at the rate of 60 miles in 60 minutes, while tidal currents rarely exceed two or three miles per hour. The tide-wave comes from Gibraltar to Cape Henry, a distance of about 3,800 miles, in about 14 hours, or at a rate of about 270 miles an hour. In rivers and bays, however, this speed is retarded, not only by the shoals and points with which the flowing waters come in contact, but also the incoming tide is retarded by the currents of the rivers flowing into the sea. So swift is the current of some rivers, that there is no surface tidal current visible, the rise and fall and a slackening of the river's current being the only indication of the change that is taking place.

In the Chesapeake Bay the tidal wave travels at the rate of about 15 miles an hour.

(TO BE CONTINUED.)

A SIBERIAN CANAL.

(M. de Mas in the *Annales des Ponts et Chaussées*.)

ABOUT 200 miles above Tomsk the Obi receives on its right bank a large tributary, the Kete River ; about 162 miles above Yeniseisk the Yenisei receives, on its left hand, a stream of less size, the Great Kass. The upper tributaries of the Kete and of the Kass come almost in contact with each other in a marshy region without any considerable elevation, so that the basins of these two great Siberian rivers can be united under conditions more favorable than are often found.

The Kete is a large river naturally navigable ; it has been followed up from its junction with the Obi, for a distance which has not been exactly measured, but which is not far from 500 miles, the head of navigation being at the mouth of the Overnaia. It is between this point and the junction of the Great Kass with the Yenisei that we find the works for providing a water-way between the two rivers.

Fig. 1, herewith, is a sketch map showing the general course of the tributaries of the two streams and of the canal which is to unite them. The works are of the nature expressed in the table below :

		MILES.
A B.	Overnaia River, Navigable	9.95
B C.	Lomovataia River, Canalized	30.50
C D.	Jassevaia River, "	21.19
D E.	Grand Lake, Navigable	3.39
E F.	Canal	4.66
F G.	Little Kass River, Canalized	31.82
G H.	Little Kass River, Regulated	22.87
H I.	Great Kass River, Navigable	127.64
	Total	252.02

From this it will be seen that all the actual canal construction needed to put the two great rivers in connection is a distance of 4.66 miles, and in this distance the excavation required is nowhere over 18 ft. in depth.

The summit level, which includes a portion of the canal, Grand Lake, and a short section of river, is now completed. The position of the terminal locks, on this level, are shown on the sketch map at *P* and *P'*. Its total length of 12.12 miles includes 5.26 miles of the Jassevaia River, the 3.39 miles across the Grand Lake, and 3.47 miles of the canal.

The cross section of the canal is shown in fig. 2, and it is remarkable for the very gradual slope of the banks of the prism. This slope was adopted on account of the sandy nature of the soil, and the result is that the banks, although not protected in any way, are perfectly preserved. The terminal locks are 155 ft. in length and 28 ft. in width, with 5.6 ft. depth of water over the sills. These dimensions allow the passage of two small boats of the type used in that country at the same time. In fig. 2 the level of high water, in the spring floods, is shown by the line *a a*; the low-water level by the line *b b*.

The work of canalizing the rivers is progressing actively in both directions, and it will probably be completed—at least as far as the construction of the locks—by the end of next summer. On the side of the Obi and Kete the Jassevaia, in a total length of 46.36 miles, has a fall of 58.7 ft., which is overcome by six locks; on the side of the Yenisei the Little Kass, in a distance of 31.8 miles, has a

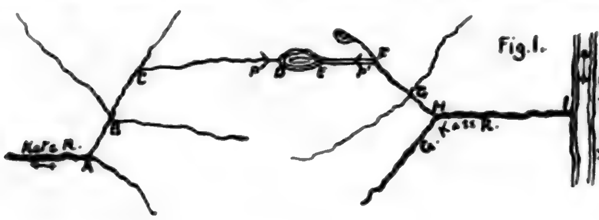


Fig. 1.

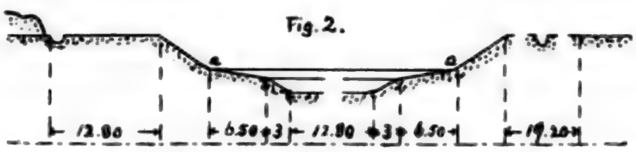


Fig. 2.

total fall of 51.6 ft., which is overcome by three single locks and one double lock.

The total estimated cost of all these works was only $950,000, but it is probable that this estimate will be considerably exceeded.

The only materials furnished by the adjoining country are wood and sand; stone is entirely unknown, and the iron, which is brought from the Ural mines, is very costly. The locks and the dams are, therefore, entirely of wood. The type adopted for the dams is worthy of attention; it consists of a fixed wooden bridge placed above the level of the highest floods, upon which rest heavy parallel timbers, the other extremities of which are embedded in the bottom of the river; the intervals between these timbers are closed by planks so arranged that they can be lifted when necessary to afford passage through for the water.

The difficulties resulting from lack of material, however, were the least of those encountered. The works are in a country absolutely uninhabited. Before beginning them it was necessary to build a village to bring the workmen there and to collect the supplies of every kind which were necessary to meet their material, moral and sanitary needs. Moreover, the rigor of the climate, where it is not uncommon to see the thermometer fall to 55° or 60° below zero, reduced the time of active work to a few months in each year. At Tomsk the average period of navigation is from May 10 to October 15. If we take into account the time necessary to transport the workmen to their place and to return them home again, it will be seen that the working season does not last over four months. During these four months from 1,200 to 1,600 men have been employed, while during the winter about 100 remained upon the ground and are employed in felling trees in the forest. About March 1 it becomes possible for carpenters to work in the open air, and a small re-enforcement is sent, but the great body of the workmen and of the necessary supplies, cannot be brought up until the Obi and the Kete are free from ice, so that boats can pass up them.

The labor, however, required will be well rewarded by the results, which will be obtained when the work is completed. The Ural Railroad, which is now completed from Perm in European Russia across the Ural Mountains to Ekaterinburg, is being extended to Tiumen in Siberia. That city is situated at the head of navigation of the Tiura River. That river falls into the Tobol, the Tobol into the Irtisch, and the Irtisch into the Obi. On the other hand, the Yenisei receives a little below Yeniseisk, the Angara, which is the outlet of Lake Baikal; lastly, this lake has for a tributary the Selenga River, which has its source among the mountains of the great Mongolian plateau, and which crosses the Chinese frontier near Kiakhta, which is the center of the overland commerce between Siberia and China.

When the Obi and the Yenisei are united there will exist a navigable route from Kiakhta to Tiumen, a distance of nearly 3,400 miles, substituting for that distance a cheap transportation for one which is now excessively costly. The importance of this will be seen when it is said that of tea alone some 18,000 tons passed through Kiakhta last year, and that the opening of the water line will reduce the cost of transportation to about one-sixth of its present amount.

It is to be considered, moreover, that this water line will make easy of access for the first time the vast valley of the Lena, now almost inaccessible. The head waters of the Ilim, the principal tributary of the Angara, approach within less than 60 miles the navigable waters of the Kout, a tributary of the Lena. The transportation of merchandise over this distance will be comparatively easy, and as the traffic increases there can be little doubt that a new canal will be constructed there.

It may be noted that the navigation of the Angara, near Lake Baikal, is at present obstructed by rapids, but M. Sibiriakoff, a distinguished engineer, who has made a careful examination of this region, has prepared a plan for a system of towing by which boats can pass these rapids with very little difficulty.

This work of connecting the Obi and the Yenisei has been under charge of Baron Aminoff as Chief Engineer; he has his headquarters at Tomsk, but passes the working season upon the ground, where he can exercise direct supervision of the construction.

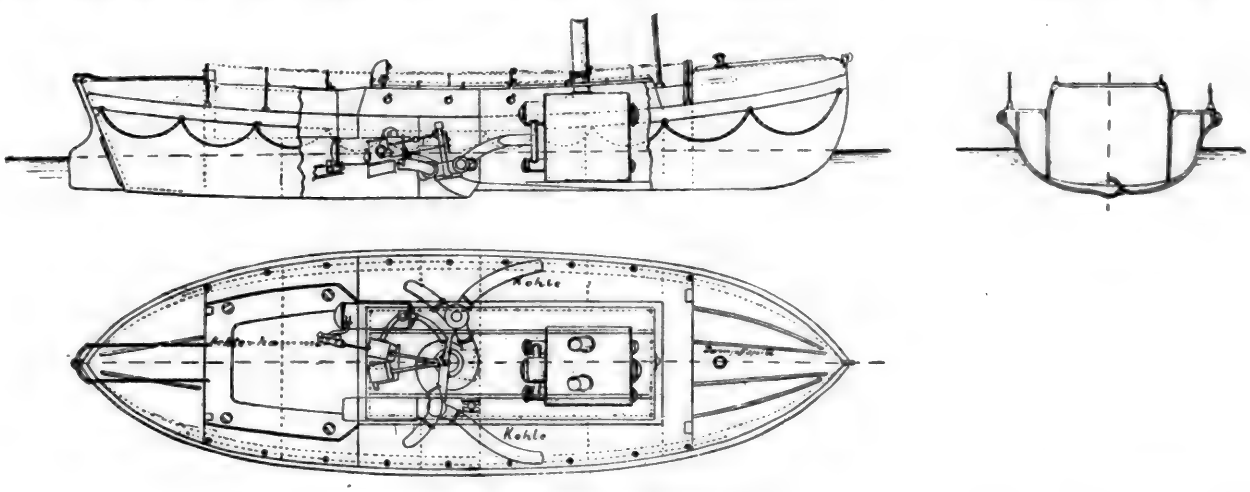
A NEW STEAM LIFE-BOAT.

THE accompanying illustrations, taken from the *Mittheilungen aus dem Gebiete des Seewesens*, show a life-boat with machinery for hydraulic propulsion, which is now under construction, and which is expected to receive the gold medal offered in England for a life-boat propelled by machinery. The boat and machinery are being built at the yards of R. & H. Green, in Blackwall, England. The illustrations show an elevation of the boat with part of the side broken away to show the position of the machinery; a plan and a cross-section.

The driving apparatus consists, as shown in the cut, of a powerful centrifugal pump, which takes in the water through pipes extending through the bottom of the boat, and expels it through other pipes passing through the sides. These are so arranged that the water can be forced out forward or backward and either to port or to starboard separately, so that the boat cannot only be propelled backward or forward, but can also be very quickly handled, turning in a very short space. The boat under construction is 50 ft. long; 12 ft. wide on the water line; 14 ft. 4 in. in breadth across the thwarts, and has a total depth of 5 ft. 6 in. With the crew, 30 passengers, and three tons of coal on board, it will draw only 3 ft. The engine is a compound engine, designed with especial reference to economy of space, and will work up to 170 H.P.; it is expected to drive the boat at the rate of 9 to 10 knots an hour.

There are 17 air-compartments placed along the sides, in order to give the boat the required buoyancy, and these are so arranged that two leaks will not impair seriously its floating power.

The arrangement of the weight is so carefully made that the boat can right itself from an angle of almost 90°, which, of course, increases very much its safety. The pump which serves to drive the boat is also so arranged that by a connection very quickly and easily made it can be used to pump water out in case any should be shipped or a serious leak sprung. The boat is provided with a mast carrying a spritsail and a jib, so that it can be sailed by wind power, and in that case the smoke-stacks can be laid flat upon the deck, in order to avoid interference with the sail. The mast is hinged at the foot, so that when not in use it can in its turn be laid down between the smoke-stacks, so as to be entirely out of the way when the boat is worked by steam.



STEAM LIFE-BOAT.

The hull is built of steel and strongly braced, and the total weight of the boat when completed and ready for service will not exceed 20 tons.

The boiler is calculated to carry a very high pressure. In the design of the boat the greatest pains have been taken to secure strength, safety, and lightness, and the speed has not been obtained at the cost of these qualities. It must be mentioned that the boat is provided with a small steam capstan at the bow, which is expected to do good service under many circumstances, and will also have the Hickman steering apparatus.

THE MOUNT PILATUS RAILROAD.

(From the *Revue Scientifique*.)

THE Mount Pilatus Railroad is the latest of the Alpine railroads, and also the most difficult of construction. Every one who has visited this line, which will be entirely open to the public in the present summer, joins in stating that the work is remarkable and that it will be a very great convenience to tourists. All strangers who visit Lucerne, the central point of voyages in Switzerland, have seen Mount Pilatus, whose lofty outline, with its sharp peaks and precipices, breaks so abruptly on the beautiful country surrounding that city. From the most remote times this strange mountain has impressed the imagination of the people of the country. From its slopes seem to come the most terrible storms. At sunset, when the other mountains are touched with the most beautiful colors, Pilatus alone always appears dark and gloomy, throwing its black shadow over the lake of the Four Cantons. Sometimes its head is hidden in the clouds, and again it towers proudly over the masses of vapor which hide its base. It has always a physiognomy different from the other mountains, and innumerable traditions have been circulated about it in the Alpine country. It was believed for a long time to be inhabited by winged dragons, phantom birds, gnomes, and petrified saints. Pontius Pilate, whose name it bears, was said to live in the little lake on the mountain, and if, by chance, any one should throw stones into that lake, he would issue forth and scatter devastation and death over the country. In the Middle Ages the people were so convinced of this fatal power of Pilate, that the City of Lucerne forbade the ascent of the mountain under heavy penalties, and the city officers took a solemn oath to prevent any one from climbing it. It is only in comparatively recent times that the veil which covered this terrible mountain has been withdrawn. Ever since the great Genevese naturalist, Saussure, made known the sublimity and beauty of the mountain world, and Albert de Haller wrote his magnificent work on the Alps, thousands of visitors have climbed the mountain, and have not been able to praise sufficiently the grandeur of the view and the sublimity of its rocks and precipices.

Early in the present century the number of visitors became so great that it was necessary to establish a resting-place for them on the mountain. About 30 years ago, houses were built on the Klimsenhorn and in the valley or depression which separates the Oberhaupt and the Esel, the two enormous masses of rock which form the summit of the mountain; but for many years the ascent was hardly possible on account of the difficulties involved. The idea was conceived of making the mountain more accessible, as had already been done with its rival on the other side of the lake, the famous Righi. Two energetic citizens of Zurich, Colonel Locher and M. Guyer-Freuler, published in December, 1885, a daring but carefully worked out project for a railroad up the sides of Pilatus. They found the necessary funds, and soon a company was organized. The names of the projectors were both well known, as they had, one as engineer and the other as contractor, already completed with notable success one of the most difficult sections of the St. Gothard line, from Flüelen to Goeschenen. To these two persons is mainly due the construction of the road, although there should, perhaps, be added a third, Major Britschgi, who rendered great service in securing the right to build a road through the commune of Alpnach, in which most of the line is situated.

Work was begun in the summer of 1886, and at the end of that of 1888, after two years—not more than half of which could be utilized on account of the severity of the weather on the mountain—the road is now substantially finished. From the village of Alpnach, which is situated at the extremity of the southwest arm of the Lake of the Four Cantons, the railroad rises by a very steep grade from a height of 1,446 ft. to one of 6,790 ft. above the sea-level, following the narrow ravine or pass between the rocky masses of the Oberhaupt and the Esel. The difference in altitude between the two extremities of the road is thus 5,344 ft. for the total length of 2.879 miles. The average grade is 42 per cent.—that is, an inclination of 22° 42′—and the maximum grade is 48 per cent., or 25° 39′. Higher grades have been overcome by cable roads, but this road

on Mount Pilatus is the only one on which grades of 48 per cent. are mounted by means of a rack-railroad system.

From the bottom of the valley the line rises across the meadows of Obsee, then enters a wooded valley and traverses the pine forest in the direction of the tremendous precipice which is known as the Wolffort. It crosses the chasm on a stone bridge, which is remarkable for its bold arch, and then passes through two tunnels to Risleten. There during centuries avalanches and landslides have formed on the side of the mountain an embankment of bowlders and rocks. Passing this, at Emsigenalp, the line reaches the region of pasturage, and at this point, which is marked by a group of gigantic pines, the station or passing place for trains is situated. The view is here already imposing. Always preserving a grade of 48 per cent., the line gains the upper level of the Mattalp, where huge and apparently impenetrable rocks are before it. The problem was how to pass these. It was done by turning a little eastward toward Rosegg, and then cutting out a line at a dizzy height on the perpendicular side of the Esel. On this section there were required four tunnels through projecting spurs of the mountain.

The daring of the location and the wildness of the surroundings here are astonishing. Looking from the Mattalp, far below, the railroad looks like a thread stretched around the side of the mountain, and it seems almost impossible that it can have been built there.

The line then traverses the western angle of the rocky summit of the Esel, and by a last stretch reaches the lofty portal of the summit station, near which is placed a hotel for the travelers who may undertake the ascent of this mountain wall.

The substructure of the railroad from one end to the other forms a continuous wall of stone, carefully fastened to the mountain and protected by a facing of granite brought from the quarries of Osogna in the valley of the Tessino.

The track is joined to the masonry by heavy iron clamps. It is composed of two ordinary rails and of the central rack-rail, which is on the Abt system, with a double row of teeth. The racks are made of steel cut out by a machine made especially for the purpose. The train consists of a locomotive having a boiler built to carry a pressure of 180 lbs., and of a carriage with four compartments arranged in staircase fashion. Its carrying capacity is 32 persons, besides the trainmen. Each carriage has two pairs of toothed wheels carried on a vertical axle, which engage on each side with the teeth of the rack. The care taken in the construction of the track, of the engines, and of the automatic brakes, which are constantly in action, excludes the idea of danger. The speed, both in ascending and descending, is about 2¼ miles an hour, and each train makes the trip up in about 80 minutes.

Rarely has a railroad been built under such exceptional circumstances as was this. The steepness of the slopes, which in the upper part are almost inaccessible, rendered the work very difficult. The engineers of the company and the workmen had as many dangers to run as the chamois-hunters and needed as much boldness and courage as they have, but under the direction of Colonel Locher and Chief Engineer Hauszler they accomplished their task with a truly heroic courage.

The difficulties of construction on the upper part of the mountain were very great. To reach the line of the road-bed it was necessary for the men to be lowered by ropes from above to their work, and drilling and blasting the rock, in places where it was impossible to find a foothold, were thus very difficult. In spite of the experience gained in the valley at the beginning of the work, the engineers and workmen found themselves constantly meeting new difficulties, and the director who had charge of each section had more than once to devise new means of meeting these obstacles.

The climatic conditions of the mountain opposed an equal obstacle to the organization and accomplishment of the work. Often the arrangements made in the morning had to be changed at noon on account of changes in the weather. This perpetual struggle against a thousand difficulties demanded far more patience and intelligence than has ever been required for the building of a railroad. Moreover, the line could not be begun at several points at once, as is the case with most railroads. The work could be carried on only at a single point, and it was not possible to make temporary roads to carry the material. A short section of the track was first built, and was then utilized to carry the material for the next section. In spite of this, however, it was necessary to employ mules as well as the united force of the workmen to move the material. The stone, cement, rails, etc., were carried by wagon to the foot of the work. Mules alone were able to resist the climate and the bad roads, and it would not have been possible to replace them by horses. As to the large stones from Tessino, they were placed on carts constructed for the purpose and drawn by 30 or 40 workmen to the place where they were to be used.

It may be noted that the working force, composed largely of Italians, was an excellent one, and that the men not only carried out their orders and did their work well, but they were always cheerful and willing.

Near the commencement of autumn it was necessary to suspend work in the open air, and it was continued in the tunnels alone, only exceptionally strong men being able to resist the winter storms at heights from 5,500 to 6,500 ft. above the sea-level. Although every measure had been taken to secure the proper feeding of the workmen and to keep up intercourse with the rest of the world, it would sometimes happen that all communication with the valley became impossible. To meet this case there were kept in the working camps stocks of biscuits, coffee, meat, etc., only to be used in case of absolute necessity.

The construction of this road and the grandeur of the work cannot be too much admired. When the first passenger train carried up Pilatus the directors of the Company there was general rejoicing.

In spite of the completion of the line, the summit of Pilatus is still covered with workmen actively employed in blasting out a level site for a new hotel, which will be placed near the summit of the Oberhaupt facing to the east and south, and protected against the storms which come from the north and northwest. Work has also been begun on a cable road, about 200 meters in length, which will carry visitors up an almost perpendicular ascent to the top of the Tornlishorn, the highest point of Mount Pilatus.

This might well be called the most remarkable railroad in Europe, and from the summit there can be attained a view without a parallel in the world.

JAPANESE RAILROADS.

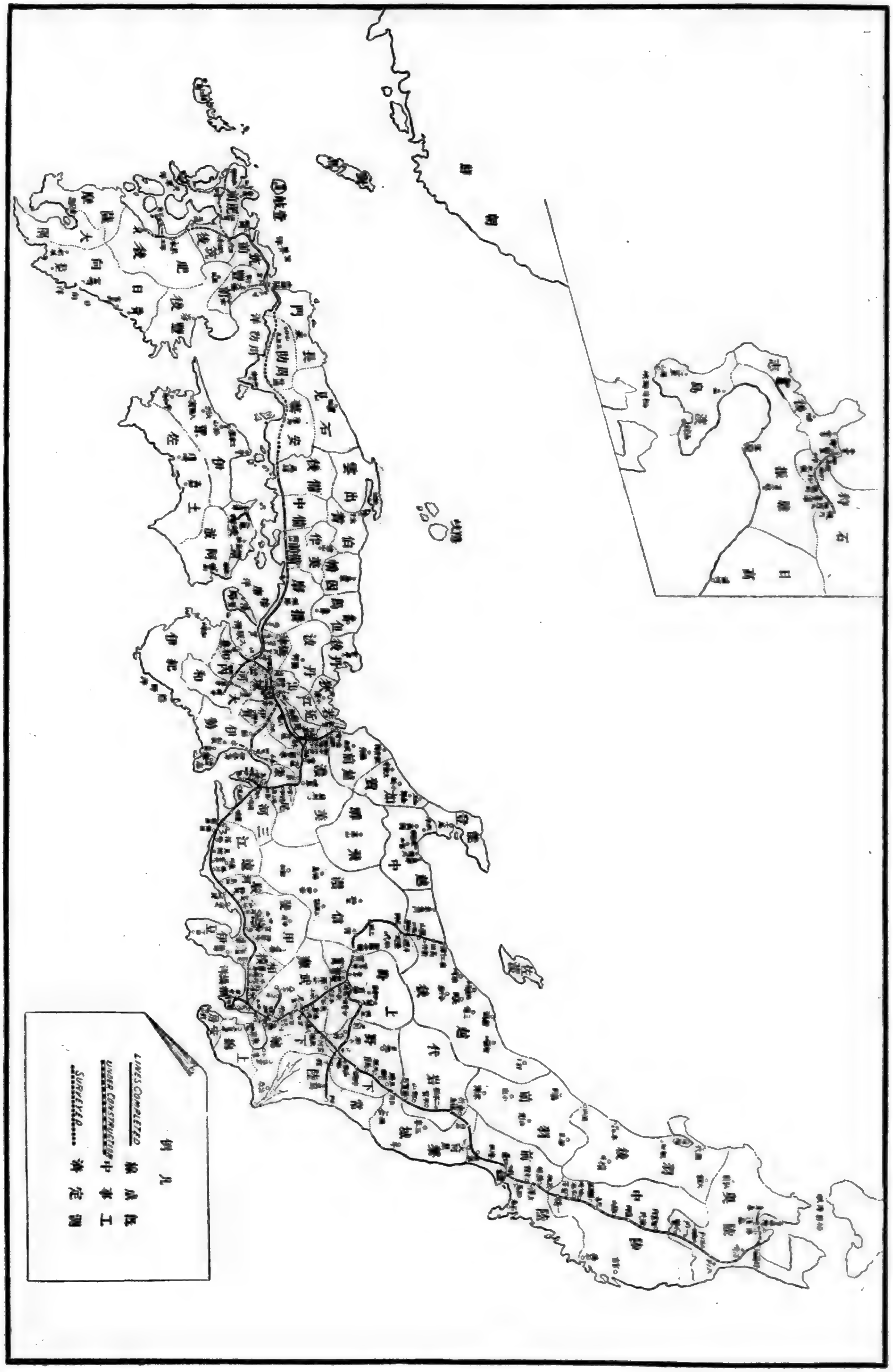
WE give below a table, compiled from the best sources, of the length of the railroads in Japan at the beginning of July, 1889, the separate columns showing the number of miles completed and in operation; under construction, and surveyed and located. A large part of the completed mileage is owned by the Government, but the lines owned by private companies also reach a considerable figure, and the greater part of the lines under construction are enterprises undertaken by corporations.

We give also on the opposite page a copy of an official map showing the location of these lines. The names are printed in Chinese characters, which, probably, few of our subscribers can read, but the general outline of the railroad system, completed and under construction, is well indicated, and the map will serve to show the careful work which is done by the Japanese engineers, and is a specimen also of the map-work done in that country—not of the finished maps, but the sketch and outline work.

Under the conditions obtaining in Japan, a line that is surveyed or under construction is pretty sure to be built, so that it may be safely said that in a year or so that country will have close upon 2,000 miles of railroad. The total now in operation, as given above, is 1,042 miles: under construction and surveyed, 923 miles; an aggregate of 1,965 miles.

In addition to these lines there are ten others projected, for which concessions have not yet been granted by the Government; the total length of these is about 600 miles.

With these, and others which will follow, Japan may look forward to a railroad system of some 3,000 miles in a few years; and this length of railroad, judiciously placed,



RAILROAD MAP OF JAPAN.

ought to give a fairly complete system of internal communication to a country of its geographical configuration.

It must be remembered that Japan differs from most other Asiatic countries in this respect, that its railroads are built with home capital and not with European money, and that they are surveyed and located by Japanese engineers, of whom the country already possesses a number carefully educated and including men of high ability. The profession also is yearly increased by the graduates of the Imperial University at Tokio.

Most of the material used in the building of the Japanese railroads thus far has come from Europe, but the policy of the country is to manufacture at home as much as possible, and the time may not be far distant when home workshops will supply all, or at least a great part of what is needed to supply the new and maintain the old railroads.

JAPANESE RAILROADS, JULY, 1889.

Name of Line.	Completed, Miles.	Under Construction, Miles.	Surveyed, Miles.
Imperial Government Railways:			
Tokyo-Kobe Line	376.39	......	......
Maibara-Kanagasaki	31.03	......	......
Ofu-Taketoyo	12.69	......	......
Bamba-Otsu	1.29	......	......
Ofune-Yokosuka	10.00	......	......
Takasaki-Yokokawa	18.00	......	......
Yokokawa-Karuizawa	......	......	15.00
Karuizawa-Maoetsu	92.13	......	......
Government Railway of Hokkaido:			
Temiya-Poronai	56.65	......	......
Niphon Railway Company:			
Tokyo-Maebashi	68.15	......	......
Omiya-Shiogama	207.81	......	......
Shinagawa-Akabane	12.95	......	......
Iwagiri-Awomori	......	240.00	......
Mito Railway Company:			
Oyama-Mito	41.56	......	......
Ryomo Railway Company:			
Oyama-Kirui	32.92	......	......
Kirui-Maebashi	......	19.80	......
Kobu Railway Company:			
Tokyo-Tachikawa	16.92	......	......
Tachikawa-Hachioji	......	4.08	......
Iyo Railway Company:			
Matsuyama-Mitsugahama	4.23	......	......
Hankai Railway Company:			
Osaka-Sakai	6.06	......	......
Sanyo Railway Company:			
Himeji-Onomichi	......	101.00	......
Onomichi-Shimonoseki	......	......	167.50
Hiogo-Himeji	33.08	......	......
Osaka Railway Company:			
Osaka-Kashiwara	10.13	......	......
Kashiwara-Kitaimaichi	......	4.88	......
Kitaimaichi-Sakurai	......	......	10.13
Kitaimaichi-Nara	......	......	11.88
Sanuki Railway Company:			
Marugami-Kompira	10.19	......	......
Kansei Railway Company:			
Yokaichi-Kusatsu	......	48.95	......
Yokaichi-Tsu	......	......	19.06
Yokaichi-Kuwana	......	......	7.91
Kiushiu Railway Company:			
Kokura-Tashiro	......	56.93	......
Kokura-Moji	......	6.60	......
Kokura-Gyogi	......	......	13.08
Tashiro-Misumi	......	......	79.99
Tashiro-Nagasaki	......	......	87.69
Arita-Sasebo	......	......	13.94
Uto-Yatsushiro	......	......	14.38
Total	1,042.18	482.24	410.56

UNITED STATES NAVAL PROGRESS.

We give below a summary of the condition of vessels in progress of construction, from a statement prepared for the use of the Secretary of the Navy, by the Bureau of Construction and Repair.

Act of March 3, 1885:	Builders.	Condition.
Newark, cruiser	Cramps	To be launched in Oct.
Charleston, cruiser	Union Iron Works	Undergoing trial.
Yorktown, gunboat	Cramps	Undergoing trial.
Petrel, gunboat	Columbian Iron W'rks	Undergoing trial.
Act of August 3, 1886:		
Maine, armored cruiser	New York Navy Yard	Under construction.
Texas, armored battle-ship	Norfolk Navy Yard	Under construction.
Baltimore, cruiser	Cramps	To be launched in Nov.
Vesuvius, dynamite cruiser	Cramps	Undergoing trial.
Torpedo-boat, No. 1	Herreshoff	Under construction.
Act of March 3, 1887:		
Philadelphia, cruiser	Cramps	To be launched in Oct.
San Francisco, cruiser	Union Iron Works	To be launched in Oct.
Concord, gunboat	Palmer & Co	To be launched in Sept.
Bennington, gunboat	Palmer & Co	To be launched in Sept.
Coast Defense Vessel	Union Iron Works	To be completed in 3 yrs.

This does not include the old monitors, appropriations for the completion of which has been made by various acts, and which have been referred to heretofore from time to time. It need only be said that of these monitors the *Terror* and the *Miantonomoh* are nearly completed.

The sum of $3,760,000 was appropriated September 7, 1888, for one armored cruiser of 7,500 tons, one protected cruiser of 5,300 tons, two protected cruisers of 3,000 tons each, and three protected cruisers of 2,000 tons each; also a practice ship for the Naval School, the latter to cost $260,000. Plans for the 2,000 and 3,000-ton vessels are complete. The 2,000-ton vessels are limited to a cost of $700,000 each, and the 3,000-ton vessels to $1,100,000 each.

The total of these figures more than exhausts the amount of the appropriation—$3,500,000. The limit of cost fixed by the Bureau for the 5,300-ton vessel is $1,800,000, and of the 7,500-ton, $3,500,000. The practice cruiser authorized by this act will be about 800 tons, armored and carrying a battery of rapid-fire guns. Plans for this vessel are well under way, and will soon be completed.

The Bureau of Construction and Repair, the Chief states, is at work on plans for the vessels authorized by the act of March 2, 1889, which appropriated $4,055,000 for construction purposes besides $140,000 for four steam tugs. Bids for these tugs have just been opened, but the contracts are not let.

The principal vessel provided for in this last act is the armored submerged cruiser monitor, known as the Thomas ship, its general design having been suggested by ex-Congressman Thomas of Illinois. Plans for it are nearly completed, and it is estimated to cost $1,500,000. Two steel cruisers or gunboats, estimated to cost $350,000 each, will be 1,200 tons each, carrying batteries of rapid-fire guns. Plans for these are well under way.

There were also provided for in the act of 1889 a harbor ram of the plan designed by Admiral Ammen, and a dynamite cruiser of the *Vesuvius* type. Nothing has yet been done toward the construction of these vessels. The cruiser is estimated to cost $350,000, but no estimate is made upon the ram.

All of these vessels, for which the plans have been completed, have been described in our columns from time to time.

THE "CONCORD" AND "BENNINGTON."

It may be mentioned here, however, that the engines of the *Concord* and the *Bennington*, which have just been completed at the Quintard Iron Works in New York, are excellent specimens of American practice in this respect. Each of these vessels has two triple-expansion engines,

with cylinders of 22-in., 31-in., and 50-in. diameter and 30-in. stroke. The engines are placed in separate water-tight compartments, the arrangement being such that the low-pressure cylinder is forward in the forward and aft in the after compartment.

The main steam-valves are of the piston type ; those of the high-pressure cylinders are of cast-iron, the others being of composition. There is one valve for the high-pressure, one for the intermediate, and two for each low-pressure cylinder. The valves are worked by a radial valve-gear, and are arranged for a minimum cut-off of 4 per cent. of the stroke in the high-pressure and 5 per cent. in the intermediate and low-pressure cylinders. The cut-offs of all the cylinders are capable of being adjusted independently of each other. The movement of each valve is regulated by a reversing-arm and a radius link. Each engine also has a steam reversing-gear.

The pistons are of steel, 2¼ in. thick at the center and 1¾ in. at the periphery, and each is provided with an adjustable cast-iron wearing-shoe. The piston-rods are of steel, 3¾ in. in diameter. The crosshead runs in guides, bolted to the cylinder at one end and to the bed-plate at the other end. Each crosshead is fitted with cast-steel slippers, lined with white metal. The connecting-rods are of wrought-iron, 64 in. between centers, 4½ in. in diameter at the crank-pin neck, and 3¾ in. in diameter at the cross-head neck.

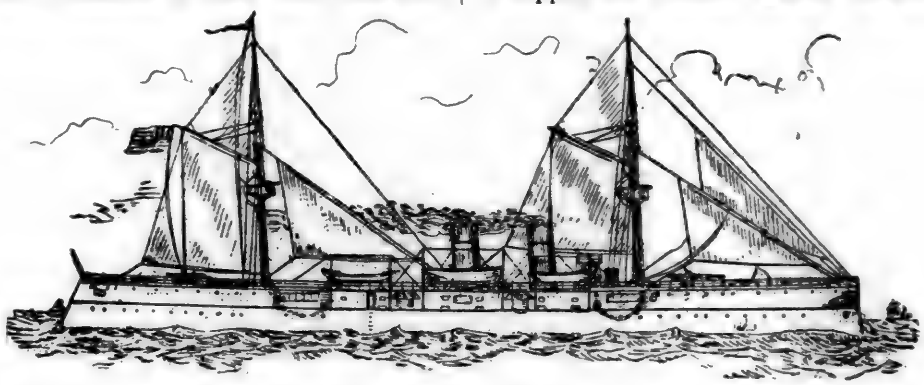
The crank-shafts are of forged steel, fitted with cranks at equal angles, and with the necessary coupling-disks forged on. The crank-webs are 6½ in. thick, except the after one of each engine, which is 7¼ in. thick. The crank-pins are 9 in. in diameter and 10 in. long. The webs are shrunk on both shaft and pins and keyed. The shaft journals are 9 in. in diameter and have a total length of 68 in. for each engine. The crank-shaft boxes are of composition, with steel caps, both lined with white metal. The castings containing the crank-shaft bearings are cast-steel in one piece for each engine. They are bolted to engine keelsons and stayed to the cylinders by tie-rods and the guides.

In the forward engine-room is a centrifugal pump, driven direct by its engine, and arranged for freeing the ship from water in case of necessity. The air-circulating and bilge pumps are driven independently of the main engines. Each circulating-pump is arranged with bilge as well as sea injection, and with a suitable by-pass valve. Each air-pump delivers into a feed-tank placed in the forward engine compartment. This tank has a capacity of about 300 gallons, and is partitioned and fitted as a filter. The shells of the condensers are cylindrical and made of brass. They are fitted with brass tubes ⅝ in. in diameter outside, and each has a cooling surface of about 2,450 sq. ft. measured on the outside of the tubes. The tubes are placed fore-and-aft, and the water can circulate through them and hence overboard through outboard delivery-valves. There are also two vertical duplex pumps fitted in each fire-room of ample capacity for feeding the boilers. One set in each fire-room is fitted to draw from feed-water tank and bottom of forward condenser and discharge through the boiler check-valves. The second set in each fire-room is fitted to draw water from the tank, sea, bilge and boilers, and discharge into the fire-main through the boiler-checks and overboard.

There are four cylindrical horizontal tubular steel boilers, containing an aggregate grate surface of 220 sq. ft. arranged fore-and-aft in two water-tight compartments, each with a fire-room athwartship and abaft the after boilers and forward of the forward boilers. Each boiler is 9 ft. 9 in. in diameter and 17 ft. 6 in. long. The shell is 13/16 in. thick. The top of the smoke-pipe is about 55 ft. above the guards. The fire-rooms are arranged to work under air-pressure, and each is fitted with two blowers, capable of constantly supplying sufficient air. The boilers will carry 160 lbs. pressure.

The line shafting is of steel, 9 in. in diameter ; one shaft is 27½ ft. long, and the other is 7½ ft. long, and each has a 4-in. hole bored through it. The propeller-shafts are of steel and are formed of two lengths, the forward one being 22 ft. 7 in. long and from 9¼ to 9¾ in. in diameter, and the after one 28 ft. long and 11½ in. in diameter. The former has a 4-in. axial hole and the latter a 7-in. hole reduced to 4 in. at the after end. The steel tubes for the reception of the propeller-shafts are located on each side of the ship, as shown in the plan view. The forward tubes are built in the framework, which is bossed out in a suitable manner to support the forward ends of the after tubes, their after ends being supported by struts. The propellers are of manganese bronze, 10½ ft. in diameter, with adjustable blades, right and left hand.

The distilling apparatus consists of one evaporator and distiller capable of furnishing 2,000 gallons of potable water in 24 hours. The vessels will be lighted throughout by electricity.



THE PROPOSED 3,000 TON CRUISER.

THE 3,000-TON CRUISERS.

These cruisers, to which some reference has been made heretofore, are described as follows by the Bureau of Construction. They have not yet been named, but are officially designated as cruisers No. 7 and 8. They will be twin screw ships, with heavy protected deck, very great speed and heavy batteries of rapid-fire guns. They have poop and forecastle decks, with an open gun-deck between and bridges along the tops of the hammock nettings connecting the poop and the forecastle.

The principal dimensions are : Length on load line, 300 ft.; breadth, extreme, 42 ft.; mean draft, 18 ft.; displacement, 3,183 tons ; tons per in., 20 ; indicated H. P., 10,000 ; speed in knots, 20.

The rudder is of a balanced type and is made to form a continuation of the lines of the ship aft. This type is much in favor abroad at present, and it will interest Americans to learn that such a rudder was placed on the Stevens battery.

The protective deck slopes at the sides in two slopes of 22° and 39°. It is first covered with plating ½-in. thick, and a 2-in. plate is worked on this on the slopes amidships, reduced to 1½ in. at the ends, and a ½-in. plate is worked on the horizontal part, making the deck's total thickness 2½ in. on the slopes amidships, 2 in. on the slopes at the ends, and 1 in. on the flat.

A coffer dam is worked along in wake of the water-line next the outside plating in the coal bunker on the slope of the protecting deck. This will be filled with woodite.

The engines are triple-expansion, vertical, inverted, and direct-acting, with a high-pressure cylinder 36 in., an intermediate 53 in. and two low-pressure 57 in. in diameter,

the common stroke being 33 in. The collective H. P. of the propelling, air-pump, and circulating engines is 10,000 at 164 revolutions. The condensers have each 7,000 ft. of cooling surface. There is a double, vertical, single-acting air-pump, worked by a vertical compound engine for each engine. The circulating pumps are centrifugal, one for each condenser worked independently.

There are four double-ended boilers and two single-ended boilers to be used as auxiliaries, placed in four water-tight compartments. Two of the main boilers are 13 ft. 4 in. in diameter and 20 ft. 3½ in. long, the other two main boilers are 14 ft. 6½ in. in diameter and 20 ft. 3½ in. long. The two auxiliary boilers are 11 ft. 2 in. in diameter by 9 ft. 0½ in. long. The working pressure is 160 lbs. The total heating surface is 19,382 sq. ft. and the grate surface 597 sq. ft.

The forced draft system consists of a blower discharging into a main duct under the fire-room floors, from which a branch duct is led to the ash-pit of each furnace, means being taken for closing the ash-pits when under forced draft and to prevent the leaking of gases out of the furnace doors.

The bunker capacity of coal for these vessels will be 556 tons, and the normal supply 400 tons. With the full supply, the radius of action at the full speed of 20 knots an hour, will be 1,243 knots, while at 10 knots an hour the cruising range will be 8,652 knots, or 36 days' voyage.

The main battery consists of one 6-in. and ten 4-in. rapid-fire, breech-loading rifles on center pivot mounts, protected by thick steel shields worked as part of the hull or made fast to the carriages. The 6-in. gun is mounted on the forecastle. Two 4-in. guns are placed on the poop, two under the poop in sponsons, two under the forecastle in sponsons, and the other four—two on a side—in sponsons. The secondary battery consists of two 6-pounders, two 3-pounders, one 1-pounder, and two 37 mm.

There are six torpedo tubes with openings about 4 ft. above the water, worked from the berth deck, fixed tubes forward and aft, and the other four, which are training tubes, are placed at the sides on the forward and after berth decks. The tubes are of the Howell pattern, using gunpowder impulse—a device much superior to the hydraulic or pneumatic telescopic rammer sometimes used.

The rig is that of a two-masted schooner spreading 7,210 sq. ft. of sail. The masts have barbette galleries for machine guns just below the tops. The boats are all stowed inboard out of the line of the fire of the guns, on skid beams.

These vessels will be provided with a complete electric light plant, including three search-lights. There will be two engines and two dynamos, so arranged that either dynamo can be connected with all or any of the circuits, so that there will be no loss of light in case of accident. A full system of ventilation, worked by blowers, is provided in addition to the usual circulating pumps, etc., and the quarters for officers and men will be more convenient than in some of the new vessels.

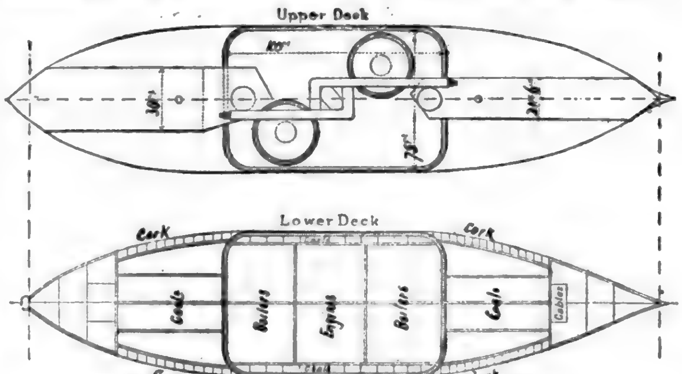
These 3,000-ton cruisers will be of a very similar type or class to the French ships of the *Davoust* type, and the English cruisers of the *Magicienne* class, both of which have been illustrated in our columns.

Bids for these vessels and for the 2,000-ton cruisers (which were illustrated in the July JOURNAL) were to be received until August 22. A number of bids, it is understood, have been sent in, but no result has been announced.

THE ENGLISH BATTLE-SHIP "INFLEXIBLE."

(From the London *Engineer*.)

THE accompanying illustration is a general view of the *Inflexible*, which is known in the English Navy as an armored turret battle-ship of the first class. It is described by Mr. W. H. White, Director of Naval Construction, as a "central citadel ship with turrets placed *en echelon*." It was built at Portsmouth and launched in 1876, but not actually completed till 1881, just in time to take part in the bombardment of the forts at Alexandria a year afterward. The engines were made by Elder & Company, and are 8,010 indicated H. P. The principal dimensions of the ship are as follows: Length, 320 ft.; beam, 75 ft.; extreme draft, 26 ft. 4 in.; displacement, 11,880 tons; speed, 13.80 knots; coal capacity, 1,300 tons. The leading characteristic in the structure of this vessel, which is quite a typical example of its class, is a huge central citadel protected by a belt and bulkheads of iron armor plates, 16 ft. high and 110 ft. in length, placed immediately over the engines and boilers, the turrets being superimposed upon a thin armored deck covering the whole. This armor is 24 in. thick in the center, thinning to 20 in. at the top and 16 in. at the bottom. Practically, it is not so strong as the sides of the *Trafalgar's* "womb," which has 18 in. of compound steel-faced armor upon it. The *Inflexible* has a raft body at either end, entirely unprotected with plating, except that a thick iron deck extends from the citadel to stem and stern, at a considerable depth below the surface of the water, which covers the magazines. These raft-body ends are made—presumably (?)—buoyant by a series of thick compartments filled with cork, and stretch-

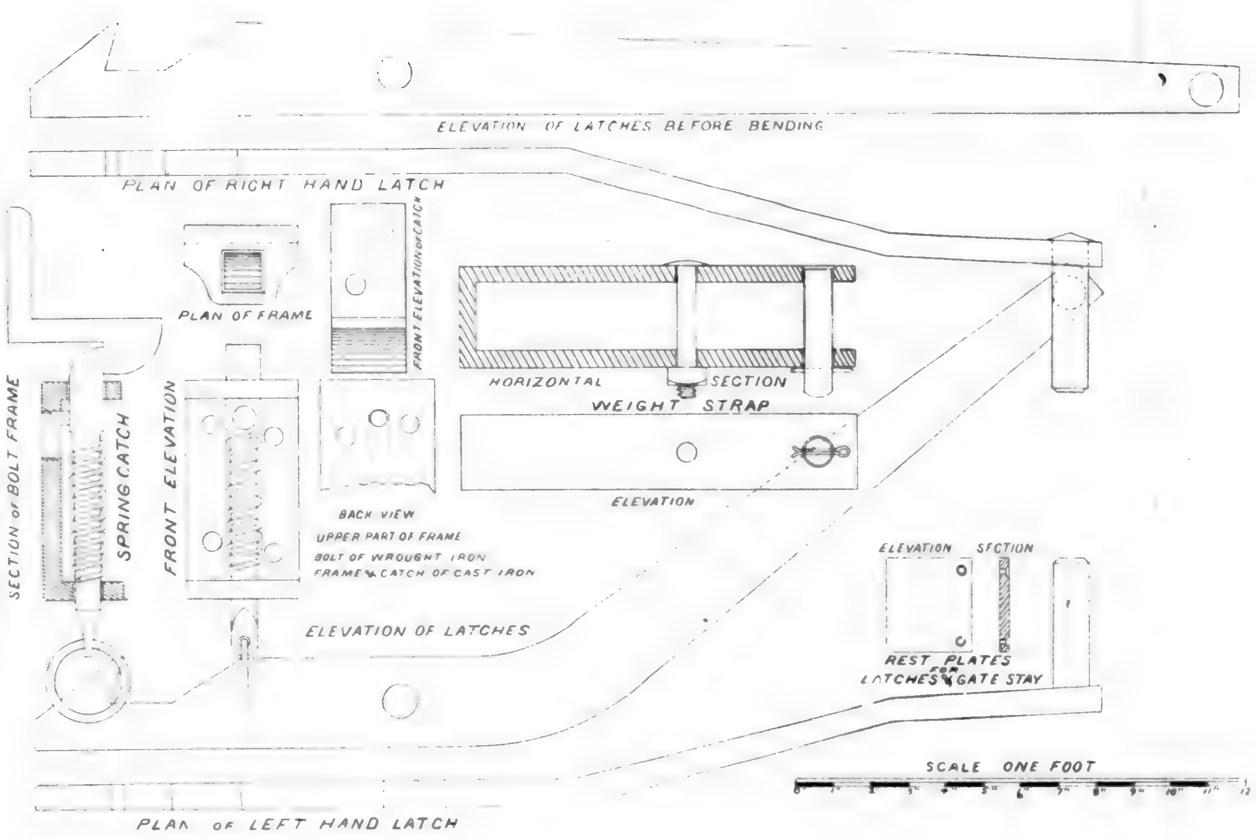


UPPER AND LOWER DECK PLANS, H.M.S. "INFLEXIBLE."

ing over half of the unprotected ends. The unprotected ends of the ship have an actual freeboard of the same weight as the top of the armor plates, and are necessarily low, so as to admit of the firing of the heavy turrret guns along their surfaces; but the superstructure gives an erroneous impression of the height of the *Inflexible*, and makes it appear as though she has a high bow. As a matter of fact, owing to her short length and considerable beam, the fore-deck outside the cabins is all a-wash in heavy weather. The central citadel has further protection, behind the armor plates and teak backing, of large coal bunkers disposed within its whole length. There is a spar deck over the superstructure at both ends, upon which boats are housed and light armament mounted. The turrets are covered with 17-in. composite armor, and each pair of guns on either side can train through an arc of 180°, so as to fire ahead, astern, or abeam. The arrangement of the guns for loading is execrable. The hydraulic machinery is so arranged that the muzzles of the guns are depressed to an opening in the deck below, immediately over the center of the vessel, and while in this loading position they point directly into the main magazines. A premature discharge under these circumstances would absolutely imperil the security of the ship. This was a fatal oversight in the construction of the *Inflexible*. The danger attaching to such badly protected ends as she possesses was also strikingly exemplified at Alexandria, where an officer was killed just outside the citadel, although below at the time, and where the ship was hulled effectively several times, though it is needless to say the citadel was not penetrated.

The armament of the *Inflexible* consists of four 16-in., 80-ton muzzle-loading guns in the two turrets, and eight 4-in. breech-loading steel guns, and 21 G. F. and machine guns within and upon the superstructure. The 4-in. guns are an afterthought. They do not form a properly constituted auxiliary battery, as they are not contained in protected stations of any sort. Moreover, there is no proper room for them, and in some cases they would interfere with the fighting of the turret guns, if rapid fire were being carried on in the heat of action. Most ingenious arrange-

THE ENGLISH BATTLE-SHIP "INFLEXIBLE."



ATCHISON TOPEKA & SANTA FE RY. CLIFTON COAL CHUTE IRONS PLATE No. 46

ments have been made in the designs of the new battle-ships, submitted by Mr. White to the naval architects, to avoid these complications. The guns are so disposed, in separate and remote positions, on several decks, as not to interfere with each other's line of fire in any way. Some of the existing cruisers will probably aim point blank at an adjoining sponson gun during rapid fire in action, unless great caution is exercised. The 80-ton guns, although not of the most recent pattern, are most formidable weapons. They fire a projectile of 1,700 lbs. weight, with a charge of 450 lbs. prismatic brown powder, and their penetration into armor plate at 1,000 yards is 23.3 in. The effect of some of these projectiles striking the forts at Alexandria was appalling. At Fort Ras-el-tin whole gun positions were wrecked in a moment by a single shot; and had the huge common shell which hurtled over the houses in the town been fitted with more sensitive fuses, whole districts would have been laid bare by their explosion. The *Inflexible's* guns are a little scored from ill-usage in the early days of pebble powder; but, even without retubing, they are good for many a long series of firings, should their services be required. The roller paths of the turrets are worn out, but this is a small matter. They should originally have been constructed of steel, not wrought iron. Re-engined, and with shallow light plating over the sides, the *Inflexible* would still be one of the most powerful of our battle-ships. The cost was about $3,240,000 for hull, and $730,000 for machinery. To this must be added the cost of the armament, bringing up the whole to about $4,500,000.

It is unlikely that any more of the *Inflexible* class will ever be built. They were the outcome of an idea which has been exploded, more particularly since the introduction of high-explosive shells. The unprotected raft bodies would be rendered mere shambles by the use of these last-mentioned projectiles, and one single shot penetrating the citadel might wreck its interior. Divided gun positions, with powerful protected auxiliary batteries, are the outcome of a better principle. But, as we said before, the *Inflexible* is well worth modification.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page* 376.)

CHAPTER XIII.

COAL-CHUTES (*Continued*).

Plates 46, 47, and 48 show in detail all the special iron work needed in the construction of the Clifton Coal-Chute as built by the Atchison, Topeka & Santa Fé Railroad.

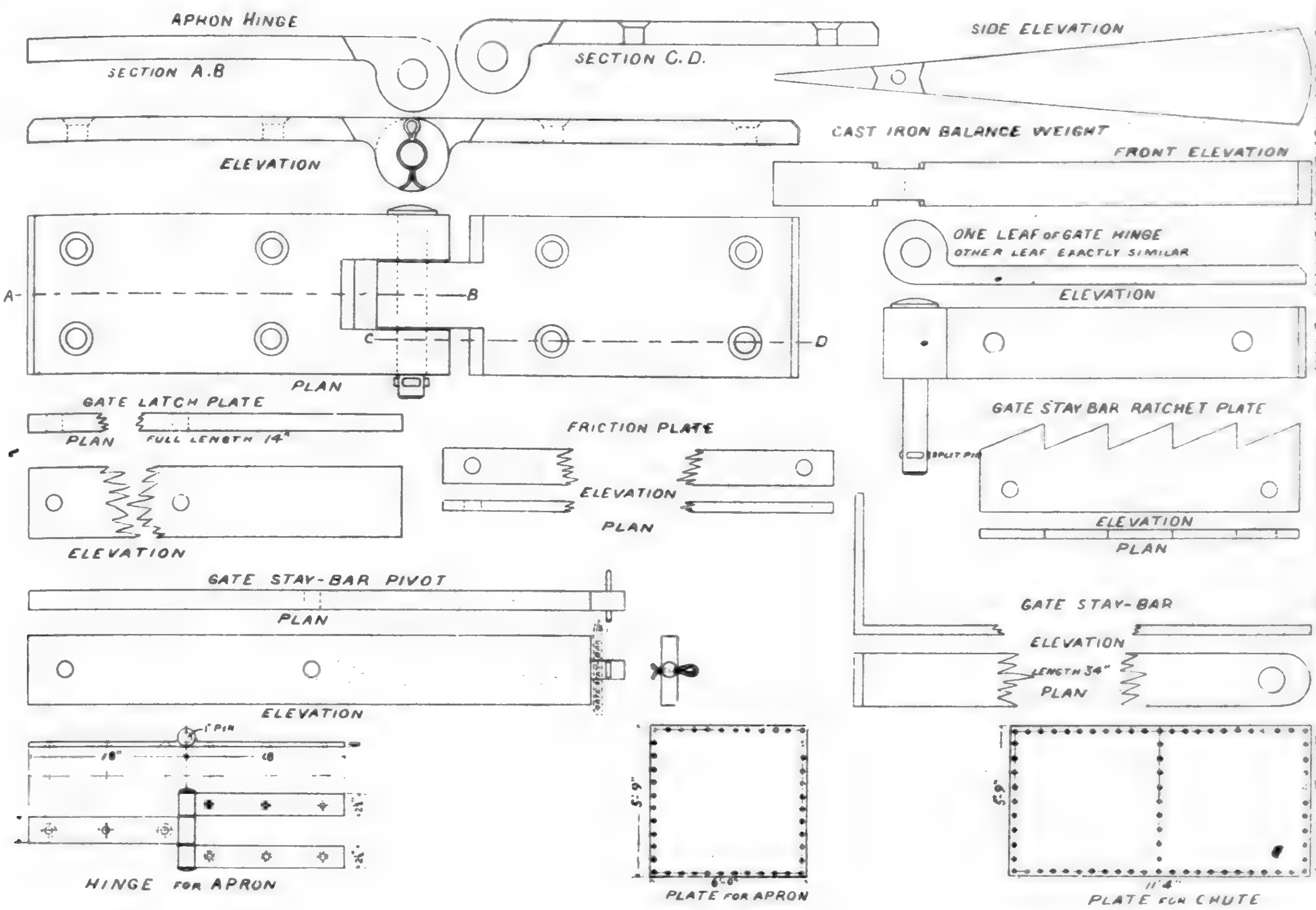
Plates 49 and 50 show sections of the chutes and method of operating. Plate 51 shows front elevation and framing. As the dimension of each piece of timber used is marked on the plans, and as everything is shown in detail, it has not been considered necessary to add a bill of material. One objection to any one bill of material would be that in very few cases are any two coal-chutes built of the same number of pockets, and that, outside of the chute proper, many of the details must be changed for local reasons.

The following directions for the erection and operation of these chutes are taken from the plans of the Atchison, Topeka & Santa Fé Railroad.

DIRECTIONS.

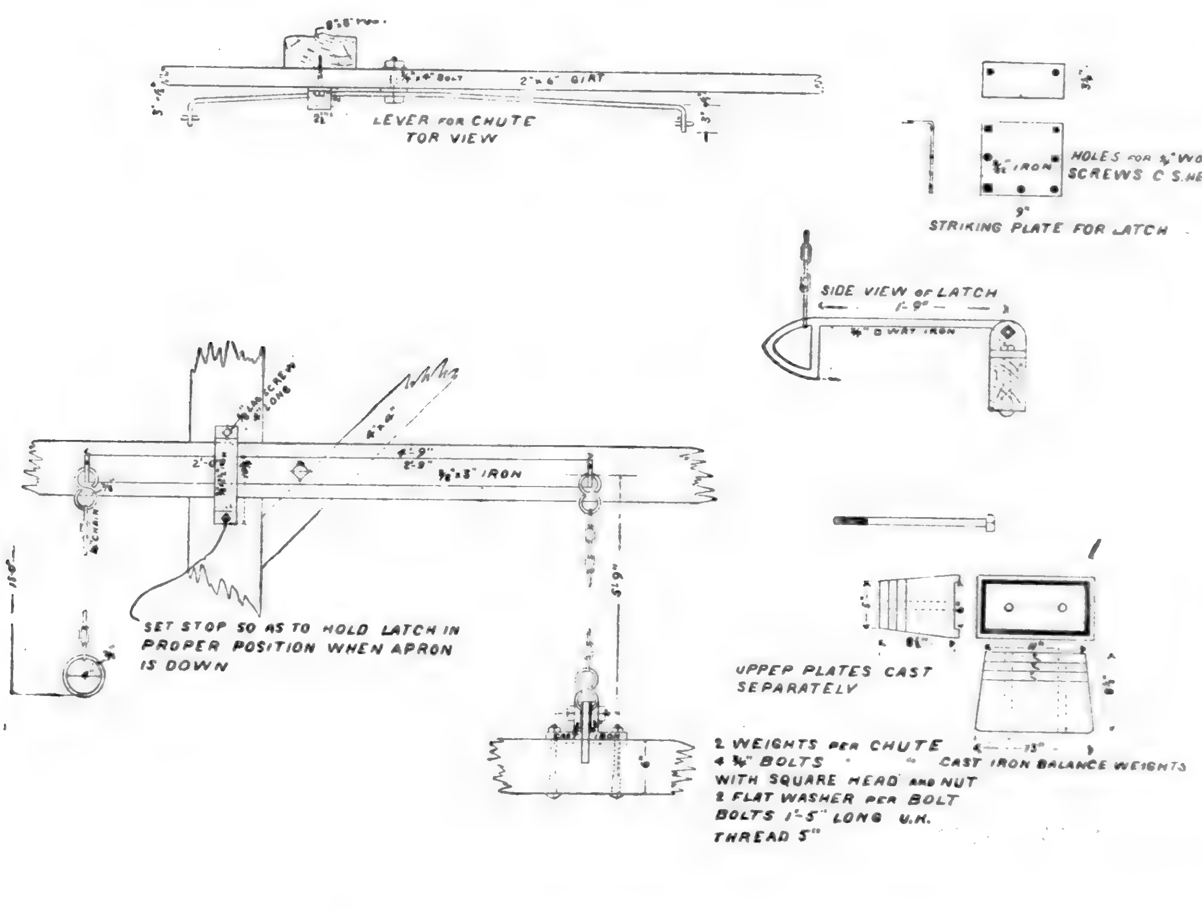
Set the center of the apron hinges *N N* 3 in. back of the face of the chute building posts, at the height shown on the plan. Set the center of the gate latch post *L* 16 in. back of the face of the chute building posts.

The gate *G* should be hung so that the lower edge of the inner face of the gate when hanging free will be ¾ in. above the bottom of the pocket, and the exterior face of the gate stay bar pivot, *E*, and gate latch plate *F*, should be 6 in. horizontally in front of the center of the gate latch



ATCHISON TOPEKA & SANTA FE RY. CLIFTON COAL CHUTE IRONS

PLATE No. 47



CLIFTON COAL CHUTE.

PLATE No. 48.

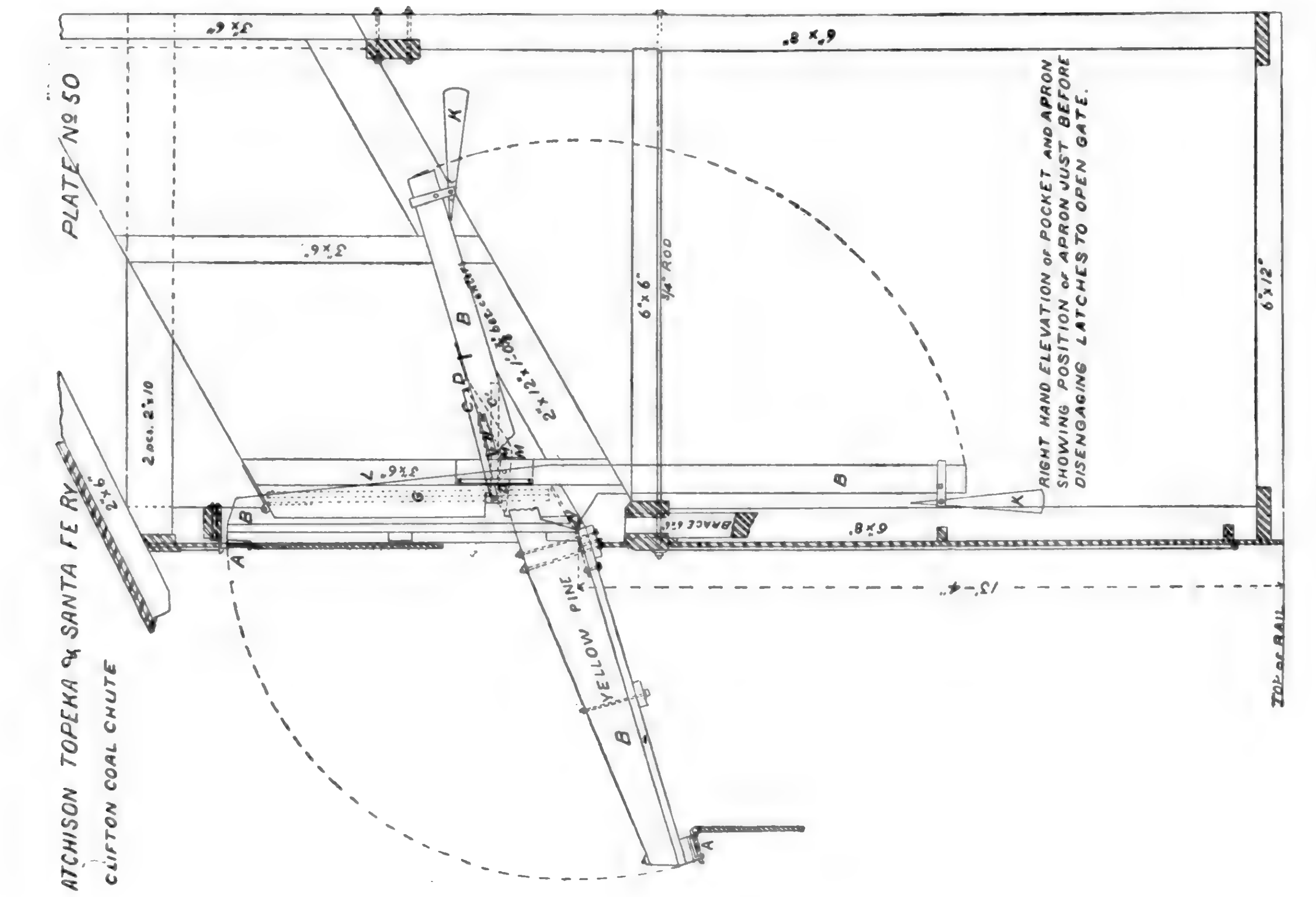


PLATE No 50
ATCHISON TOPEKA & SANTA FE RY
CLIFTON COAL CHUTE
RIGHT HAND ELEVATION OF POCKET AND APRON SHOWING POSITION OF APRON JUST BEFORE DISENGAGING LATCHES TO OPEN GATE.
YELLOW PINE
13'-4"
TOP OF RAIL
6"x6"
3/4" ROD
6"x12"
6"x8"
3"x6"

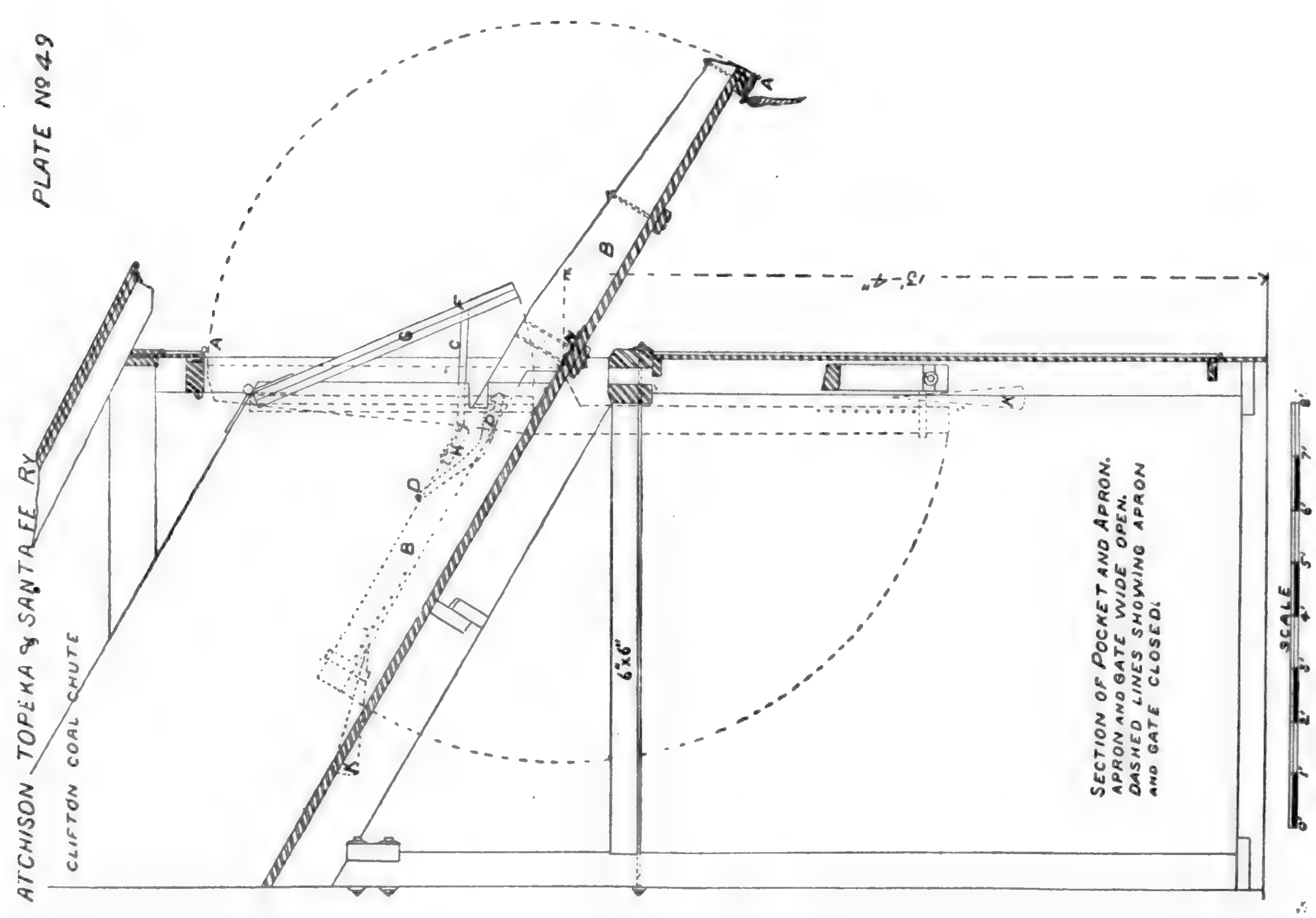
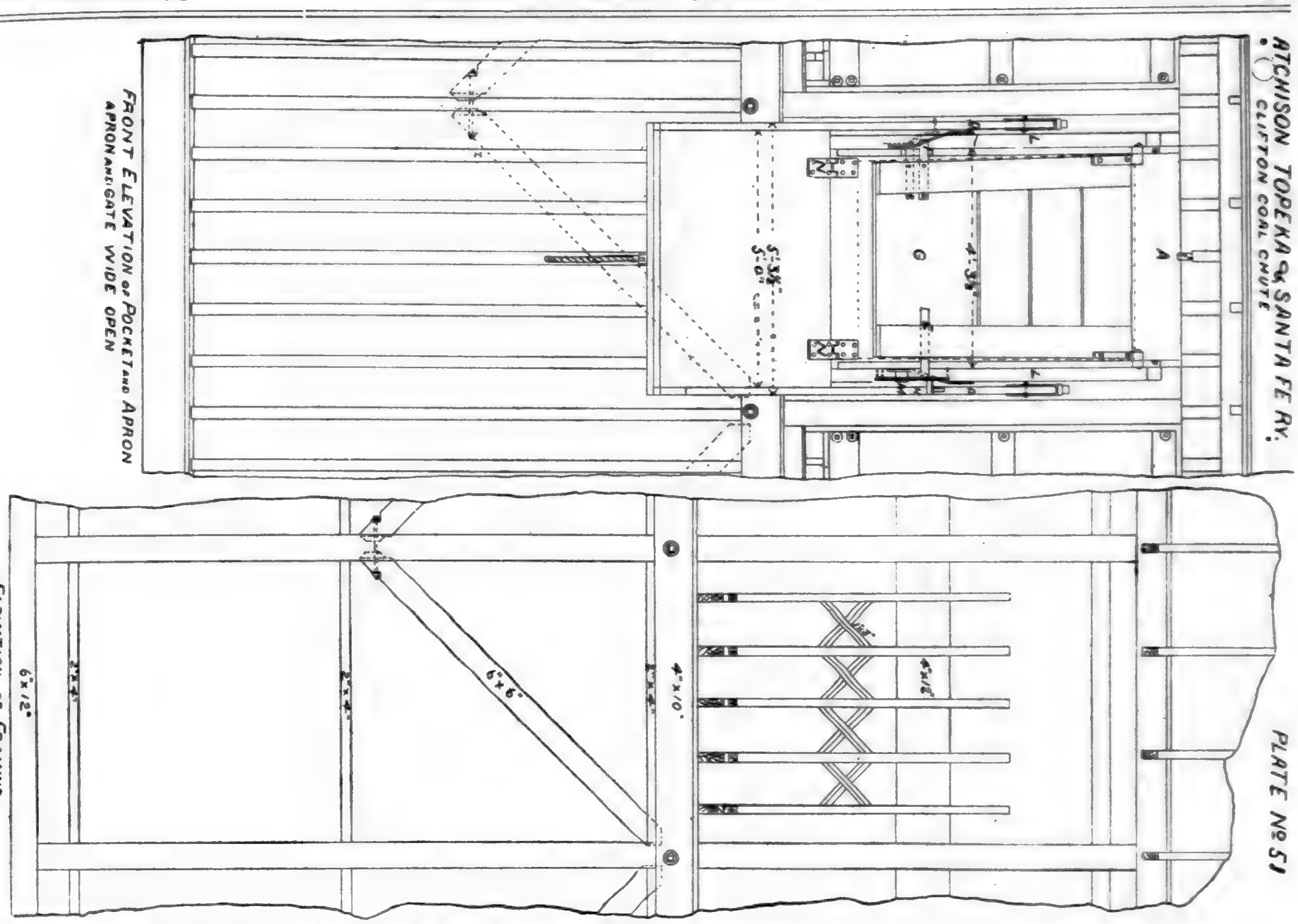


PLATE No 49
ATCHISON TOPEKA & SANTA FE RY
CLIFTON COAL CHUTE
SECTION OF POCKET AND APRON. APRON AND GATE WIDE OPEN. DASHED LINES SHOWING APRON AND GATE CLOSED.
13'-4"
6"x6"
SCALE



post, the centers of the pivots and latch being placed 1 ft. above the bottom of the gate. The centers of the bolts on which the gate latches turn should be placed in the center of the gate latch post, and 1¼ in. below the center of the gate stay bar pivot. The rest plate, *M M*, should be set so as to hold the stay bar and latches in the positions *C'* and *D D*, respectively, in Plate 50.

THE OPERATION.

The pocket being charged, and the apron and gate in position—as shown by the dotted lines on Plate 49, and by the hair lines and dotted lines on Plate 50—by means of the rope attached to the spring catch *A*, disengage the bolt and pull down the apron *B B* to the position indicated in Plate 50, which will carry the gate stay bar *C* from *C'* to *C* (Plate 50), and catch the handles of the latches *D D*; upon still farther depressing the apron, the latches will be disengaged from the gate stay bar pivot *E*, and the gate latch plate *F*, when the pressure of the coal will open the gate *G* to the position shown in Plate 49, or some intermediate position; the bent arm of the gate stay bar engaging with the ratchet plate *H*, and holding the gate open so long as the apron is kept in the position shown in Plate 49. When the coal is discharged, the apron being loosed will return to its original position by the action of the cast-iron balance weight *K*; the latches and gate stay bar resting upon the rest plates *M M*.

(TO BE CONTINUED.)

The Largest Merchant Steamer.

(From the London *Times*.)

THE new steamship *Teutonic* of the White Star Line arrived at Liverpool on Monday, after her first trial cruise. She is characterized by several novelties, and is especially interesting on account of her being the first merchant vessel built to comply with the conditions of an Admiralty subsidy. As she is to take part in the review of the fleet at Spithead on Saturday, she is fitted with four of her complement of 12 guns. They are of the type commonly known as 5-in. guns, having a range at extreme elevation of over five miles. The charge consists of a cartridge of 12 lbs. and a steel-forged shell of 45 lbs., containing a bursting charge of 2 lbs. A shot of 200 yards should penetrate a 5-in. plate of wrought iron; and it is estimated that half the shots fired should hit a target less than a yard square at a mile distant. The guns are to be placed six on either side upon the promenade deck, and those at present in position are fixed at the extremities of the ship.

The vessel has been built by Messrs. Harland & Wolff for Messrs. Ismay, Imrie & Company, and may be regarded as absolutely the safest ship afloat. She is fitted with twin screws, and the whole of the machinery, engines, boilers, and coal for working either screw is shut off completely from its neighbor by a fore and aft bulkhead, which extends from the after end of the engine-room to the forward end of the foremost coal bunker, and, in fact, intersects the six largest of the 12 water-tight compartments made by the 11 ordinary transverse bulkheads. This fore and aft bulkhead is pierced by only one locked door, the key of which is held by the chief engineer. The doors between the engine-rooms and the stokeholes are in every instance duplicated, and the duplicate door is in every case under the control of the captain on deck. When liberated they close by their own weight, but by an ingenious contrivance their descent is freed from violence. Ascending from the door is a rod surmounted by a piston, which works in a cylinder 4½ in. in diameter filled with glycerine. When the door is allowed to descend the whole of this glycerine has to pass through a hole in the piston, and the sluggish liquid thus prevents a rapid and dangerous descent of the massive door.

There is, however, another and more interesting novelty about these doors. In the event of water flowing into the ship the doors will close automatically. As the water rises in the bilge it will buoy up a hollow piston attached to a rod. This rod, on being pushed up about a foot, removes the catch that holds the door, and it might chance that the first information of danger in the engine-room would be the automatic closing of these protective doors. The principle is common enough. It is merely an adaptation of the domestic ball cock; but, assuming the buoyancy sufficient for the work to be done, nothing could be more certain in its action. The introduction of the fore and aft bulkhead dividing the separate engines of a twin-screw ship has been objected to by high authorities, on the ground that if one side were filled with water the list would be so great that the vessel would inevitably overturn, and that what was conceived as a means of safety would become a source

of certain danger. It has, however, been experimentally demonstrated in this case that if the two largest compartments on one side of the fore and aft bulkhead were filled the list would be only 12°, and facilities are at command to correct this by pumping in water on the other side.

The engines are triple-expansion, with three cylinders of 43 in., 68 in., and 110 in. in diameter, and they have been constructed to develop 17,000 H.P. The pistons have a 5-ft. stroke, and the machinery, in accordance with Admiralty requirements, has all been placed below the water-line. The boilers are 12 in number. Some are 12 ft. and some 12 ft. 6 in. in diameter, and 17 ft. long, with six furnaces in each, and a grate area of 1,163 ft. The furnaces are fed with forced air to a moderate extent above the fuel and under the grate, and the boilers are designed to work up to 180 lbs. The initial pressure in the intermediate cylinder is 80 lbs., and in the low about 16 lbs., with a vacuum of 7. The full pressure was not reached during the experimental cruise; indeed, some of the furnaces were not lighted.

The propellers, which are 21 ft. 6 in. in diameter, with a pitch of 28 ft. 6 in., and a superficial area of 128 ft., form a subject of special interest in this ship on account of the unusual manner in which they are placed. They overlap each other to the extent of 5 ft. 6 in., or, in other words, they each extend over the center line 2 ft. 9 in. The centers of their shafts are 16 ft. apart, and the port side propeller is 6 ft. forward of the starboard, measuring from boss to boss. The port propeller is a left-handed screw, and the starboard a right-handed; thus both work away from the ship, and the port propeller working in the loose water of the after screw makes two revolutions a minute more than its twin. The propeller shafts are 199 ft. and 205 ft. long, respectively, and are entirely encased to the boss of the screw. The hull is very much cut away under the stern, and a large space has been cut in the frames to admit of the massive casting that carries the screw shafts. The stern post is connected with the rudder-post by a bar on a line of the keel in the ordinary way, the scheme of allowing the rudder to be suspended without support below having been abandoned as dangerous

The vessel herself is 582 ft. long—the longest ship afloat; 57 ft. 6 in. broad, 39 ft. 4 in. deep, and has a gross tonnage of 9,685 tons. She has a cutter stem, and, relying wholly on her two sets of engines, the masts are little more than three bare poles without yards. Thirty feet up the foremast is a sort of crow's nest for the lookout.

Accommodation is provided for 300 first-class, 150 second, and 750 steerage passengers. She has a promenade deck 245 ft. long, with a clear way of 18 ft. on each side of the deck-houses. Some portion of this promenade is covered by an awning deck, which is used for stowing the boats.

For the fittings and decorations throughout the boat, it must suffice to say that they are unusually lavish, even in these days of sumptuous ocean traveling.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 383.)

CHAPTER XXXIV.

ACCIDENTS TO LOCOMOTIVES.

QUESTION 816. *What are the most serious accidents which may happen in running a locomotive?*

Answer. The most serious accidents are:

1. Collision of two trains approaching each other.
2. Collision of a moving with a standing train.
3. Collision of trains at the crossing of two railroads.
4. Running a train into the opening left by an open draw-bridge.
5. Escape of an engine without any one on it.
6. Running off the track.
7. Explosion of the boiler.
8. Bursting or rather collapse of a flue.
9. Overheating and burning of the crown-sheet.
10. Blowing out of a bolt, stud, rivet, cock, or any accident which makes or leaves a hole in the boiler for the escape of steam or water.
11. Failure of the feed-pumps, injector or check-valve.
12. Breaking or bursting of a cylinder, cylinder-head, steam-chest, or steam-pipe.
13. Breaking or getting loose of the piston or cross-head or bending of the piston-rod.
14. Breaking or bending of a connecting-rod or crank-pin.
15. Breaking of a tire, wheel, or axle.
16. Breaking of a spring, spring-hanger, or equalizer.
17. Breaking of a frame.
18. Breaking or getting loose of a part of the valve-gear.
19. Failure of the throttle-valve.
20. Breaking of the smoke-box front or door.
21. Breaking of a coupling between the engine and tender, or between the tender and front part of train, or between two cars.
22. Failure of the air-pump or other part of the brake.

QUESTION 817. *What should be done to prevent a collision when two trains are approaching each other?*

Answer. The obvious thing to do is to stop the trains as soon as possible. This is done by applying the brakes at once with all their power, and then reversing the engine, although it is best not to do the latter until the train is somewhat checked, as there is always danger of bursting the cylinder or breaking the cylinder-heads, piston, or connections if an engine is reversed suddenly at a high speed. Of course the higher the speed, the greater is the danger of injury from this cause, and therefore it is best, if there is time, first to check the speed of the train before reversing the engine. When the engine is reversed, the sand-valves should be opened so as to increase the adhesion of the wheels, so that when their motion is reversed they may check the speed of the train as soon as possible. On perceiving danger ahead the order of procedure should be as follows:

1. Shut the throttle-valve.
2. If the train is equipped with hand-brakes alone, blow the danger signal for their application, or if the train has a continuous brake, apply it with its full force.
3. Reverse the engine and open the throttle and the sand-valves.
4. If a collision is inevitable, shut the throttle-valve before the engines meet, because if it is left open after the collision, and when the speed of the train is checked, the engine, if not disabled, will by its own power crush through the wreck, and thus do additional damage.

To the credit of locomotive engineers, it can be said that they rarely leave their engines, no matter how imminent the danger is, until after they have applied all the means of checking th· speed of the train. If a violent and dangerous collision is inevitable, then an engineer may protect himself by jumping from his engine, or remain on it as may seem best; but he is in duty bound to do all in his power to prevent dangerous collisions, especially if he is running a passenger train.

QUESTION 818. *What kind of collisions occur oftenest?*

Answer. What are called "tail-end collisions"—that is, collisions of trains which run in the same direction, although there are unfortunately many collisions of trains running in opposite directions, or "butting collisions," as they are called.

QUESTION 819. *What should be done if another train is approaching a standing train, and there is danger of a collision?*

Answer. The locomotive runner of the standing train should start his engine in the same direction as the approaching train is running as quickly as possible, because the shock of the collision will be very much lessened if both trains are moving in the same direction compared with what it would be if one was standing still.

QUESTION 820. *What should be done to avoid a collision at a railroad crossing?*

Answer. If there are no interlocking and distant signals at the crossing, trains should always come to a dead stop before crossing another railroad on the same level.

If there are interlocking and distant signals, the engineer should be absolutely sure that they indicate to him that the crossing is clear. If by reason of fog or inadvertance in looking for the signals or *any other reason* he has the slightest doubt about the position of the distant signal, he should slack up when he passes it so as to be able to stop before he reaches the home signal at the crossing. If, however, through any cause danger of a collision should be incurred at a crossing, then evidently the one train should be stopped and the other moved out of the way as soon as possible. It is a safe rule for all persons, as well as locomotive engineers, to adopt, *never to cross a railroad without first stopping to see whether the road is clear.* If those who drive horses as well as those who drive locomotives, and also foot travellers, would scrupulously observe this rule, many lives and much suffering would be saved each year.

QUESTION 821. *How can an accident by running into the opening at a draw-bridge be avoided?*

Answer. The precautions to be taken are very much the same as those which should be observed at crossings. It is a safe rule ALWAYS to come to a dead stop before reaching a

draw-bridge, and second, never start again until it is absolutely certain that the draw is closed. Of course if a locomotive runner of an approaching train finds a draw open, the only thing he can do is to stop as soon as possible.

QUESTION 822. *What measures should be taken to prevent locomotives from escaping and running away without a responsible person on them?*

Answer. In the first place, when a locomotive is left standing the throttle-valve should always be *closed* and *fastened;* the cylinder cocks should also be opened, so that if any steam leaks into the cylinders it will not accumulate there, but will escape, and the reverse lever should be placed in the center of the sector, so that if by any accident the throttle should be opened the engine will not start.

QUESTION 823. *If a locomotive should escape, what should be done, and how may it be captured?*

Answer. The firs thing to be done is to telegraph to the stations toward which the escaped engine is running, either to keep the track clear, or, if there is a train approaching, to open a switch, and thus let the engine run off the track. An escaped engine may be captured by a swifter engine following it, but this is always attended with great danger, as the first engine may leave the track or become wrecked. A safer plan is to telegraph ahead of the escaped engine, and have an engine placed in a position where the track can be seen for a long distance in the direction in which the runaway is expected. As soon as the latter comes in sight, the waiting engine should start in the same direction, so that when they get near to each other they will both be running the same way and at nearly the same speed. By regulating the speed of the front engine, the following one may be allowed to come up to it quite gently, and then a man can easily climb from the one engine to the other, and thus both be stopped.

QUESTION 824. *What should be done in case an engine gets off the track?*

Answer. The first thing to do is to close the throttle-valve and "signal for brakes,"* or apply the continuous brakes if the train is equipped with them, and then reverse the engine. As soon as the engine has stopped it should be seen that the proper signals are given to protect it from approaching or following trains. If the boiler is in such a position that the heating surfaces are liable to be uncovered with water, they may get red hot and be burned. If there is danger of this the fire should be either drawn, quenched with water, or extinguished by covering it with sand, gravel, earth, sod, or snow, and then wetting the covering.

QUESTION 825. *How is a locomotive replaced on the track in case it gets off?*

Answer. If the engine is still standing on its own wheels, and has not gone far from the rails, it can usually run itself back by the aid of hydraulic jacks, wrecking frogs, or blocking under the wheels. Generally it can be replaced on the track best by running it the reverse direction to that in which it ran off. Often a derailed engine can be put back with the aid of another engine when it could not run itself back. It is impossible to give any directions for replacing locomotives on the track which will meet the great variety of circumstances which occur in practice. If an engine has fallen on its side or has run down an embankment, it is usually necessary to send for the appliances which are now provided on nearly all roads for removing wrecks and replacing engines on the track. These appliances are generally stored in what is called a wrecking or tool car, which is placed at a convenient point on the road, from which it can be sent to any place where its services are likely to be needed. Such cars are provided with ropes, jack-screws, chains, crowbars, levers, etc., to be used in such cases, and generally a special set of men is sent with the wrecking car to direct and assist in replacing engines and cars on the track. It would lead us too far to describe all the methods of doing this employed under various circumstances; and as such work seldom forms part of the duties of a locomotive runner, a complete description would be out of place here.

QUESTION 826. *After an accident which disables the engine, what is the first thing to do?*

Answer. The first thing to do is always to "*protect the train;*" that is, to send out signal men in each direction to stop approaching trains; otherwise they might run into the wrecked train, and thus cause a double accident.

QUESTION 827. *What is the chief cause of boiler explosions?*

Answer. The cause of all boiler explosions, as happily expressed by a prominent American engineer,† is THAT THE PRESSURE INSIDE THE BOILER IS GREATER THAN THE STRENGTH OF THE MATERIAL OUTSIDE TO RESIST THAT PRESSURE. This may occur in two ways: first, and most frequently with locomotives, from insufficient strength of the boiler to bear the ordinary working pressure; and second, from the gradual increase of heat and pressure until the latter is greater than the boiler was calculated to bear.

Insufficient strength may be due: 1, to defects of the original design, owing to the ignorance of the strains to which the material of the boiler will be exposed, and its power of resistance; 2, to defective workmanship and material, which can usually be discovered by careful inspection; 3, to the reduction of the original strength of the boiler by ordinary wear and tear or neglect, which can also usually be discovered by careful inspection.

The first two causes have been fully discussed in the part relating to boiler construction, and the last under the head of inspection of locomotives.

Over-pressure is nearly always due to some defect of the safety-valve, or to the fact that it is overloaded. This latter often occurs when safety-valves are set by an incorrect steam gauge, which indicates too little pressure. Over-pressure may also occur by letting an engine stand alone with a large fire in its fire-box and possibly with the blower turned on.

A boiler may, by suddenly opening the throttle-valve, undoubtedly be subjected to very severe strain that may possibly be sufficient to cause its destruction, even though it had sufficient strength to bear the ordinary pressure at which the safety-valve blows off. Suddenly opening or closing the throttle-valve may produce a violent rush of steam and water against the part of the boiler whence the steam is drawn. The percussion of the water and steam in such cases has been known to shake the whole boiler, and to lift the safety-valve momentarily right off its seat.* The weakest parts of a locomotive are the two sides where the barrel joins the outside fire-box. Many boilers, especially those with a high wagon-top, have flat spaces at this point, which it is impossible to stay properly. It is at this point, too, that the expansion and contraction of the tubes and the outside shell exert their greatest strains, and it will therefore be found, generally, that the seams at this point begin to leak before any others, and for these reasons it is believed that all the seams which join the outside shell of the fire-box to the barrel should be double-riveted.

The practice of ascribing steam-boiler explosions to obscure causes has been productive of much mischief, as it engenders a carelessness on the part of those having charge of them, who have been led to believe that no amount of care will avail against the mysterious agents at work within the boiler. Explosions are also, in the absence of other convenient reasons, very generally attributed to shortness of water. This is often nothing more than a convenient method of shifting the responsibility from the builder or owner of the locomotive to the runner or fireman, who, if not killed by the explosion, in many cases might just as well be, so far as his ability to defend himself is concerned.†

QUESTION 828. *What should a locomotive runner and fireman do to avoid and prevent explosions?*

Answer. 1. The height of the water in the boiler should always be maintained so as to cover the heating surfaces. 2. The boiler should be kept as clean—that is, as free from scale, mud, and other impurities, as possible. 3. It should never be subjected to strains from sudden heating or cooling. 4. The steam-gauge and safety-valves should be examined and tested frequently, to be sure they are in order; and, 5. they should examine every part of the boiler which is accessible, but especially the stay-bolts, to see that there is no fracture of any part or any injurious corrosion or other dangerous defect.

QUESTION 829. *If from any defect of the safety-valve or other cause the steam should rise beyond the limit of pressure that should be carried, what should an engineer do?*

Answer. He should open the furnace door and heater cocks, and let the steam blow into the tank, start the injector, and if the case is critical blow the whistle, which will allow some of the steam to escape.

QUESTION 830. *What should be done in case of the bursting or collapse of a tube?*

Answer. As soon as possible after it occurs, the runner must stop the train and reduce the steam pressure. The water escaping from the flue will usually quench the fire. When the steam pressure is reduced the engineer should close, first, the end of the flue in the fire-box, and then that in the smoke-box, by driving in *iron plugs*, which are usually provided for the purpose. These plugs are attached to the end of a bar, with which they are inserted into the tubes. If the escape of water and steam from the tube is so great as to make it difficult to see the end of the tube, the steam may sometimes be drawn up the

* This expression means, among railroad men, to signal to brakemen by blowing the whistle to apply the brakes.

† See Fifth Annual Report of the American Master Mechanics' Association, page 196.

* Wilson on Boiler Construction.

† *Ibid.*

chimney by starting the blower. If, however, the escape is so great as to make it impossible to insert the plug, then the steam pressure must be reduced by running with both pumps on, or by starting the injector ; or it may be necessary to smother or draw the fire and cool off the engine. When a flue collapses, the front end of which is behind the steam or petticoat pipes, it is usually necessary to cool off the engine before a plug can be inserted, especially if any considerable amount of water and steam escape from it. While driving in the plug, the engineer and fireman should always keep themselves in such positions that the plug cannot hit them in case it is blown out by the steam. If the engine is not supplied with iron flue-plugs, a wooden plug can be cut of the proper size and driven in. This can be attached to the bar referred to and inserted ; but if no such bar is carried with the engine, the wooden plug can be made on the end of a long pole and then cut nearly off. It is then inserted into the flue and driven in and broken off. It will be found that such plugs will burn off even with the end of the flue, but will not burn entirely out.

QUESTION 831. *What should be done in case a bolt, stud, rivet, or cock blows out of the boiler and thus allows the steam or hot water to escape?*

Answer. If it is accessible, cut a plug on the end of a long pole and drive it into the hole in the same way as described above. This will avoid the necessity of cooling off the engine ; but in some cases it will be found that a plug cannot be inserted or driven in without drawing the fire and cooling off the boiler.

QUESTION 832. *In case it is found necessary to draw the fire and cool off the boiler, and if so much water has escaped as to uncover the crown plate, what must be done?*

Answer. If the leak has been stopped or the fault remedied, one of the safety-valves should be taken off and water poured into the boiler with pails or buckets through the opening left by the removal of the safety-valve until the crown sheet is covered. The fire may then be kindled again and the engine complete its journey. When bituminous coal is used for fuel, the necessity for drawing the fire in case of accident may often be avoided by completely covering or "banking" the fire with fine coal which has been wet, and closing the dampers and opening the furnace door. In this way the fire may be smothered and the boiler cooled without putting the fire out, so that after the defect is remedied it will not be necessary to rekindle it.

QUESTION 833. *What must be done in case of the failure of one or both the injectors, feed-pumps, or check-valves?*

Answer. If one of the injectors or pumps fails the other one may be used, but the defect or obstruction to the first should be remedied as soon as possible, because the second may also fail. A description of the most common defects of injectors will be found in answer to questions 785 and 786.

QUESTION 834. *In case a pump fails, how should it be examined in order to discover the defect?*

Answer. It should first be seen whether there is plenty of water in the tank, and whether the strainer is obstructed or not. The working of a pump is usually indicated by the stream which escapes from the pet-cock. If, when this is opened, steam and water escape, it is an indication that the check-valve is not working properly. If it is not working well hot water will escape if the pet-cock is opened when the engine is standing still, but the pump may still feed the boiler if the upper or pressure-valve works properly. When the check-valve does not work as it should, it is also indicated by the heating of the feed-pipe, owing to the escape of hot water from the boiler through the check-valve when the pet-cock is opened. If, when the plunger is drawn out of the pump, air is sucked in through the open pet-cock, then the upper or pressure-valve of the pump does not work, but the working of the pump may still be secured by the working of the check-valve ; but if the pump, air-chamber, and feed-pipe then get filled with air, the plunger may compress this air at each stroke, and as it can then follow the plunger during its outward stroke, the latter will not suck water, but will simply compress the air during the inward stroke, which will then expand during the outward stroke. This will be indicated by the escape of air from the pet-cock when the plunger is moving inward, and the suction of air when the plunger is moving outward. This can be known by holding the hand in front of the pet-cock. Usually, however, the air is mixed with water, so that the stream which escapes from the pet-cock is broken or irregular. If air escapes from the pet-cock during the inward stroke of the plunger, but none is sucked in during the outward stroke, it shows that there is a leak somewhere in the pump or pipes, and that it is pumping air instead of water. The leak may be in the stuffing-box of the plunger, the joints of the pump or pipes, in the hose or their connections with the supply-pipe or tender. If neither air nor water escapes from the pet-cock during the inward stroke of the pump plunger, or if the stream of water at that time is weak, then it indicates that the suction or lower valve of the pump is not working properly. The same thing will occur if the pipe, pump, or tender-valve is obstructed. If there is a cock, as there always should be, just above the suction-valve, it will aid us very much to discover the fault when the pump will not work. If, when this cock is opened, cold water escapes from it, the fault is in the suction-valve ; if hot water, then it is the pressure and check-valves which are leaky, obstructed, or broken, and consequently the hot water from the boiler leaks back into the pump. In the absence of such a cock, the fault can often be discovered by feeling the pump barrel with the hand. If the pump cannot be made to work, and the fault is found to be in the lower valve, it must be taken out and examined ; or if the fault is in the pipes, it can usually be easily remedied. If the pipes are burst with only a small fracture, it can usually be repaired temporarily by covering the aperture with canvas or rubber and wrapping twine around it tightly. The upper valve of a pump must, however, never be taken down without first being sure that the check-valve is tight, because if it is not, the person will be likely to be scalded in taking the pump apart.

Only after all the appliances for feeding the boiler have failed and the water is so low as to be in danger of exposing the crown-sheet, should the fire be drawn or banked, and the runner should then at once give the proper signals for warning and the protection of his train, and if he is unable to repair the pumps or injector, he must send for aid to the nearest accessible point.

Directions for taking care of pumps in cold weather have already been given in the answers to Question 242.

QUESTION 835. *What are the principal causes of broken cylinders and cylinder-heads?*

Answer. Such accidents are usually caused by collisions, water in the cylinder, broken cross-heads, piston-rods, main connecting-rods, crank-pins, or pistons.

QUESTION 836. *What is often the origin of such accidents?*

Answer. They are often due to neglect in opening the cylinder-cocks, taking up lost motion in boxes, keys, or bolts. Lost motion of the brass bearings of the main connecting-rod, or a loose key in the piston-rod, or loose bolt in the follower-plate cause an undue strain on the connected parts which eventually results in a breakage. The same thing occurs when such parts as the pistons, piston-rods, guides, or pump-plunger are out of line.

QUESTION 837. *What should be done in case of the breaking or bursting of a cylinder or cylinder-head?*

Answer. If the guides, cross-head, main connecting-rod and crank-pin are uninjured they need not be removed, but the piston-rod may be disconnected from the cross-head, and the piston should be taken out of the cylinder. If any of the above parts are injured so that they will not work, then the main connecting-rod must be taken down on that side of the engine. In doing this care should be taken to put back, in their proper places, all liners—if there are any—in the straps. This will save some trouble in replacing the rods. The piston should then be moved to the front or back end of the cylinder and wooden blocks be placed between the guides so as to fill up the space between the cross-head and the end of the guide-bars, and thus prevent the cross-head and piston from moving. If a single guide is used blocks can be put above and below the cross-head, and bolted or tied with rope in their places. It is usually best to block the piston at the extreme back end of the cylinder, because in that position, if it should get loose and be driven to the front end, less damage would be done than would follow if the piston was at the front end and was driven backward so as to injure the back-head, guides, etc. On some engines, such as moguls and consolidations, the piston must be placed in the front end of the cylinder when the cross-head is blocked, because the crank-pin of the front driving-wheel will not clear the cross-head if the latter is at the back end of the guides. When the cross-head is blocked the valve stem should be disconnected from the rocker, and the valve moved to the middle of the valve face, so as to cover up both steam-ports and prevent steam from entering the cylinders and moving the piston. It can be known whether the valve is in the middle of the valve face by admitting a little steam to the steam-chest and opening the cylinder-cocks. If it is not in the middle of the face, so as to cover both ports, steam will escape at the end of the cylinder whose port is uncovered. When the valve is in the middle of the face no steam—excepting that due to the leakage of the valve—will escape at either end. It must then be fastened in that position by screwing up *one* of the bolts of the stuffing-box of the valve stem, so as to make the gland bind against the valve stem. When metallic packing is used the valve stem must be wedged or tied in its place.

If both front cylinder-heads are broken and the working parts of the engine are uninjured the steam-chest cover should be taken off, and the front steam-ports filled with wood. The engine can then be run with a light train, by admitting steam into the front ends only of the cylinders.

If one or both of the cylinders are disabled the train should be run cautiously to the next station. If the engine is not able to haul the train, then it should be uncoupled and run to the first telegraph station or other point where the aid of a helping engine can be obtained or telegraphed for. In the mean while, the train must be protected by the proper signals. Should the engine continue its journey, it must be started, if it should happen to be standing at the dead-point, by *pushing* or by means of *crow-bars*. In so doing, however, the bars should not be put between the spokes of the wheels, as they may easily be caught in the wheels when the engine starts, and in this way the spokes be broken or the persons who are using the crow-bars be badly hurt. If it is necessary to disconnect the engine, in freezing weather, then all pipes, pumps, and injectors liable to freeze must be drained. If there are no cocks or plugs for this purpose, then the connections should be slacked up so as to allow the water to run out, and when it is possible to do so blow steam through the pipes to clear them of water.

QUESTION 838. *In case an engine must be towed, what must always be done?*

Answer. The main rods and the valve stems must always be disconnected, for the reason that it is impossible, or very difficult, to keep the pistons and valves properly lubricated without steam on the engine, and, therefore, if they were in motion when the engine was running without steam, they are liable to cut the cylinder and valve-seats. If there is danger of the water in the boiler and in the tank freezing they should both be emptied.

QUESTION 839. *What must be done in case a steam-chest or steam-pipe is broken?*

Answer. The main rod and valve stem on that side must be disconnected, as already explained. If a steam-chest is broken a block of wood should be bolted over the mouth of the steam passage, so as to prevent the escape of the steam from the steam-pipe on that side. It will sometimes require considerable ingenuity to devise means of fastening such a block or blocks of wood so as to cover the mouth of the steam passage. As cylinders are now usually made, the blocks can be fastened by cutting them to the proper form and size, and then placing a thick block on top, and bolting the steam-chest cover down on top of it. If the cover is broken, a part of it may be used or a piece of plank with a few holes bored into it, or fish-plates may be employed instead. In some cases a piece of board can be bolted over the end of the steam-pipe. When the latter is broken, it should be taken down and a piece of board or plank bolted over the opening of the T-pipe to which the steam-pipe was attached. Usually it is difficult to take down a steam-pipe in the smoke-box, for the reason that the bolts and nuts are rusted fast and cannot be unscrewed.

QUESTION 840. *What must be done if a piston, cross-head, connecting-rod, or crank-pin is broken or bent?*

Answer. If the piston, cross-head, or main connecting-rod or main crank pin is broken, the same course must be pursued as when a cylinder is broken. If a coupling-rod or a crank-pin of a trailing-wheel of an engine with four coupled wheels is broken, then it is necessary to take down both the coupling-rods, but not to disconnect the main connecting-rods or their attachments, unless they are injured. On engines with six or eight wheels coupled, if any excepting the main crank-pins are broken, then the only coupling-rods which must be taken down are those connected to the pair of wheels on which the crank-pin is broken.

QUESTION 841. *If one of the coupling-rods connected to a pair of wheels is taken down, why must the other one be taken down also?*

Answer. Because if only one rod is used on a pair of wheels there is then nothing to help the cranks of those wheels past the dead-points, so that in starting, or if they are moving slowly when they reach these points, they are quite as likely to revolve in one direction as the other. If they happen to turn in the reverse direction to that in which the wheels to which they are coupled are moving, then the crank-pins of one or the other pair of wheels are very liable to be broken or bent.

QUESTION 842. *What must be done if a driving-wheel or tire breaks?*

Answer. If a tire on a main driving-wheel or the wheel itself breaks, the driving-box of the broken wheel or tire should be held up clear of the rails by putting a wooden block under the box. If the crank-pin, connecting-rods, etc., have not been injured it is not essential to take the coupling-rods down. If, however, it is necessary to disconnect the main rods on both sides, then, of course, all the coupling-rods must be taken down. If both of the main driving-wheels have been disabled, then both of them must be blocked up. It is possible, but not probable, that both tires and even part of both wheels might be broken, leaving the crank-pins and connecting-rods intact. In that event by blocking up the boxes it would not be essential to disconnect any of the rods. Usually, however, when both of the main driving-wheels are broken both sides must be disconnected and the engine be towed in.

If a trailing or leading driving-wheel or tire is broken the wheel should be blocked up and the coupling-rods connected to the pair of disabled wheels must be taken down. When both trailing wheels or axles are broken the engine can sometimes be run to a side track by supporting part of the back end of the engine on the tender. This can be done sometimes by chains and pieces of rails or timber, attached either to the engine or tender frame. An ordinary American engine can then be run on three driving-wheels, but it must be run with the utmost caution. If the engine has more than four driving-wheels there is usually less difficulty in running it, if one of the main wheels is injured, than if there are only four.

QUESTION 843. *What should be done in case the flange of a tire or wheel is broken?*

Answer. All that can be done is to run very cautiously and slowly, especially over frogs and switches.

QUESTION 844. *What should be done in case a driving-axle breaks?*

Answer. If a main driving-axle breaks outside of one of the boxes, the wheel next to the break should be removed, the box blocked up, and the engine be disconnected on that side and all the coupling-rods on the other side be taken down. The engine can then be run without the train to the nearest telegraph station. If the main axle is broken between the boxes, all that can be done is to disconnect both sides, block up the wheels of the broken axle, and send for assistance.

If a leading or trailing axle breaks the coupling-rods connected thereto must be taken down. If the break is outside the boxes, the loose wheel must be removed, and its box blocked up. If the break is between the boxes, both wheels must be blocked up and the engine run without the train, as described for broken wheels or tires.

It is almost impossible to give directions which will be applicable to all the accidents of this kind that may occur to different kinds of engines. In such cases, if assistance or a telegraph office is near where the accident occurs, it is usually best to send for help at once, rather than take the risks which attend the attempt to run an engine so seriously injured.

QUESTION 845. *What must be done if an engine-truck wheel or axle breaks?*

Answer. It is usually best to chain up the end of the truck-frame over the broken axle or wheel to the engine frame and place a cross-tie across the other end of the truck-frame, between it and the engine frame, so that the weight of the engine may rest on the cross-tie. If a part of the flange or a piece of the wheel is broken out, the wheels should be turned around so that the unbroken part will rest on the rail, and they should then be chained or otherwise fastened so that they cannot revolve, and thus be made to slide on the rails and carry the weight of the engine in that way. The same plan is employed if a tender wheel breaks, but one end of a tender-truck frame must be chained up. It is usually necessary to place a cross-tie across the top of the tender, and fasten the chains to it.

QUESTION 846. *What must be done in case a driving-spring, spring-hanger or equalizing-lever breaks?*

Answer. As the breaking of a spring or spring-hanger may cause a more serious accident, the engine and train should be stopped as soon as possible after it occurs. If the hanger is broken and there is a duplicate on hand, it should be substituted in place of the broken one. If there is no duplicate, then the spring should be taken down, and a wooden block be placed between the top of the driving-box and the frame to support the weight which before rested on the spring. In order to insert this block, if it is a front spring which is broken, it is usually best to raise the engine with jack-screws or run the back wheels on inclined blocks of wood placed under each of the back wheels. This raises the weight off from the front wheels, and the block can then be inserted betwen the box and frame. If it is one of the springs over the back wheels which is broken, the front wheels should be run on the wooden wedges. Such wedges can soon be cut out of a cross-tie with an axe, or by sawing a square stick of wood diagonally it will make two such wedges. The end of the equalizing lever next to the broken spring must be supported by inserting a piece of wood under it. This will usually be held securely by the weight which is suspended from the opposite end, bearing the blocked end down on the block.

In case a hanger breaks a chain may be used as a temporary substitute.

QUESTION 847. *What should be done if an engine-truck or tender spring breaks?*

Answer. Very much the same course must be pursued that is employed when a driving-spring breaks, excepting that usually the weight can be lifted off from a truck-box easier by placing a jack under the end of the truck-frame than by the

method described. Usually, too, each of the truck-springs supports the weight on two of the wheels, so that the two boxes must be blocked up.

QUESTION 848. *If a truck wheel or axle breaks or an axle is bent, what should be done?*

Answer. If a back wheel of a truck is broken it can be chained up, clear of the track, to a cross-tie on top of the engine frame or on top of the tank, or it can be fastened so that it cannot revolve and be allowed to slide on the rails. If a front wheel or axle of a four-wheeled truck is broken or bent, the engine may be jacked up and the truck turned around so as to bring the sound pair in front.

QUESTION 849. *What must be done in case the engine-frame is broken?*

Answer. Usually very little need be done excepting to exercise more than usual caution in running, and to reduce the speed. Of course the breakage of a frame may disable the engine, but ordinarily in such accidents that is not the case.

QUESTION 850. *How can it be known if an eccentric has slipped on the axle?*

Answer. It is indicated at once by the irregular sound of the exhaust, or, as locomotive runners say, the engine will be "*lame.*"

QUESTION 851. *When it is known that an eccentric has slipped, how can it be learned which is the one that is misplaced?*

Answer. This can usually be learned by examining the marks which should always be made on the eccentrics and on the axles. If no such marks have been made by the builder of the engine, the engineer himself should make them, after the valves have been set correctly. The effect upon the valve when an eccentric slips is either to increase or diminish the lead. Therefore, by running the engine slowly with the link first in full forward and then in full back gear, and observing whether steam is admitted at each end of the cylinder just before the crank reaches the dead points, it can be known which eccentric has moved. If it has slipped in one direction the lead will be increased and steam will be admitted to the cylinder some time before the piston reaches the end of the stroke. If it has moved the opposite way, the lead will be diminished and steam will not be admitted until after the piston has reached the end of its stroke. The admission of steam will be indicated by its escape from the cylinder-cocks.

QUESTION 852. *If by any means the valve stem or either of the eccentric rods should be lengthened or shortened, how can it be known?*

Answer. The crank on one side should be placed at one of the dead points and the cylinder-cocks opened; then admit a little steam to the cylinder, by opening the throttle-valve slightly, and throw the reverse lever from full gear forward to full gear backward, and observe whether steam escapes all the time from the end of the cylinder at which the piston stands. Then repeat the operation with the crank at the other dead point. If either of the eccentric rods or the valve stem have been lengthened or shortened, it will cause the valve to cover the steam-port either at the front or back end of the cylinder, so that no steam will escape from the cock at that end. If the length of one of he eccentric rods has been changed, then when the altered rod is in gear the valve will have too little or no lead at one end of the cylinder and too much at the other. If, therefore, this occurs when the forward rod is in gear and *not* in back gear, it indicates that the length of the forward rod has been altered. If the reverse occurs it shows that it is the back-motion rod whose length has been changed. It must be observed that if the length of an eccentric rod is altered the lead will be changed only at that part of the link which is operated by the altered rod. That is, if the forward eccentric rod is too long or too short, the lead at the front and back ends of the cylinder in forward gear only will be affected. If the back eccentric rod is changed the valve will be affected only in back gear. If, however, the length of the valve stem is changed, the lead will be changed in both forward and back gear. The valves on each side of the engine can, of course, be tested in the same way.

QUESTION 853. *When it is discovered which eccentric has slipped, how should it be reset?*

Answer. If it has been marked, it is simply turned back so that the marks correspond with each other again. This is done by first loosening the set-screws, and, after the eccentric is turned to the proper place, tightening them up again. When an eccentric slips it is often caused by the cutting of the eccentric-straps, valve or other part of the valve-gear, so that these should always be examined to see whether they are properly oiled. If the eccentrics have not been marked, the valve may be set by placing the crank at the forward dead-point, and the reverse lever in the front notch of the sector and the full part of the forward-motion eccentric *above* the axle. Then admit a little steam into the steam-chest, open the cylinder-cocks, and move the forward-motion eccentric slowly forward until steam escapes from the front cylinder-cock, which will show that the steam-port is opened and the valve has some lead. To set the backward-motion eccentric the crank is placed in the same position, but the reverse lever is thrown into the back notch and the full part of the eccentric is placed *below* the axle. Then move this eccentric forward until steam escapes from the *front* cylinder-cock as before. In order to verify the position of the eccentrics the crank may be placed at the back dead-point and the reverse lever moved backward and forward, at the same time observing whether steam escapes from the back cylinder-cock when the link is in both back and forward gear.

QUESTION 854. *What should be done in case an eccentric-strap or rod, or rocker arm rocker shaft, or the valve-stem breaks?*

Answer. If an eccentric-strap or rod breaks, the broken rod and strap should be taken down, and the valve-stem disconnected from the rocker and the valve fastened in the middle position of the valve face, and the engine should be disconnected on one side and be run with one cylinder only. The same course must usually be pursued if a rocker breaks. If the valve-stem breaks, it is not necessary to disconnect the link and eccentric rods, but simply to fasten the valve in the center of the valve face.

QUESTION 855. *If a link hanger or saddle, or a lifting arm should break, what may be done?*

Answer. The valve-gear may be used on that side of the engine by putting a wooden block in the link slot above the link block, so as to support the link near the position at which it works the valve full stroke forward. Of course the engine can then be run in only one direction, and should therefore be run with the utmost caution. If, however, it should be necessary to back the train on a side track, it can be done by taking out the wooden block and substituting a longer one, so that the link will be supported in a position near that at which it works the valve full stroke backward. These blocks must be fastened in some way, either with rope or twine, so that they will be held in their position when the engine is at work.

QUESTION 856. *If the lifting shaft itself or its vertical arm, the reverse lever or rod, should break, what can be done?*

Answer. If it is impossible to devise any temporary substitute or method of mending them, but both links can be blocked up as described above. The engineer should determine as near as he can the point of cut-off at which the engine must work to reach its destination. For forward motion long pieces of wood would be placed below the link-block and short ones above. To back the engine these pieces must be reversed. The same plan can be used if one or both of the lifting shaft-arms, the reversing rod, the link-hanger, or the hanger-pin breaks.

QUESTION 857. *If a valve, valve-yoke, or valve-stem is broken inside of the steam-chest, how can it be known and located?*

Answer. It will make itself known by the irregular exhaust of the steam. To ascertain on which side the defect, is one of the crank-pins should be placed at a dead-point, and the throttle-valve and cylinder-cocks opened. Then move the reverse-lever from full stroke forward to full stroke back. In doing this, if the valve gear is in good condition, the valve will have lead alternately at the front and the back end, and steam will escape from the front and back cylinder-cocks as the reverse-lever is moved. If the valve-stem or yoke is broken the valve will not be moved as it should be by the reverse-lever, and if the valve is broken, probably it will be indicated by the irregular or constant escape of steam. By trying both sides of the engine the defect can thus be located.

QUESTION 858. *If the valve, valve-stem, or yoke is broken, what must be done?*

Answer. If the valve-stem is broken outside of the steam-chest the valve must be moved to cover both parts and then fastened in that position and the engine disconnected on that side, as already described. If the break is inside, the steam-chest cover must be taken off and the valve secured, with blocking or otherwise, so as to cover the ports, and the opening for the valve-stem must be closed with a wooden plug inserted from the inside of the chest, so that the steam pressure will not blow it out.

If the valve is broken a wooden board 1 in. thick should be placed over the valve face and blocks placed on top of it, so that when the steam-chest cover is screwed down it will hold the board on to the valve face.

QUESTION 859. *If the valve face is broken, what should be done?*

Answer. If the metal of the face is broken, so that the front port cannot be closed, then the piston should be fastened at the back end of the cylinder and the valve should be secured, so as to cover the exhaust and the back steam-ports, that side of the engine being disconnected. If the back steam-port is the one injured, then the piston and valve should be placed in the reverse position. If either of the bridges between the ports are broken, then the valve should cover all of them.

QUESTION 860. *In case the throttle-valve should fail, what should be done?*

Answer. If such an accident occurs, especially if it happens about a station, it is attended with great danger. If it is found that steam cannot be shut off from the cylinders with the throttle-valve, all the brakes should be applied and the reverse-lever should be placed in the middle of the sector. If this does not prevent the engine from moving, the reverse lever should be alternately thrown into forward and then into back gear, and at the same time every aperture, such as the safety-valve and heater-cocks, should be opened, and every means be taken to cool the boiler as quickly as possible. The fireman should open the furnace door, close the ash-pan dampers, and start the blower so as to draw a strong current of cold air into the furnace and through the tubes. At the same time the injector should be started and the fire drawn as quickly as possible. After the boiler is cooled, the cover of the steam-dome may be removed and the valve examined if the defect cannot be discovered in any other way. Of course if the accident occurs on the open road, the train must be at once protected by sending out signals in each direction.

QUESTION 861. *What must be done in case a coupling breaks?*

Answer. When a coupling between the cars or tender breaks, if the front end of the train is immediately stopped, there will be danger that the back end of it, which is broken loose, will run into the front end, and thus do great damage. As it always occurs, when a coupling of a passenger train breaks, that the signal bell in the cab is rung, the first impulse of a runner under such circumstances is to stop the engine. He should, however, be careful not to do so if on shutting off steam he finds that the train has broken in two, but should at once open the throttle in order to get the front end of the train out of the way of the rear end. The ease with which the speed of a train is arrested with continuous brakes has increased the danger of accident from this cause. Usually a runner learns by the sudden start of the engine that the train has separated, and when that occurs he should never apply the brakes.

QUESTION 862. *If from any cause the supply of water in the tender becomes exhausted, what must be done?*

Answer. It is best, if it can be done without risk of injury to the engine, to run the train on a side track and then draw the fire. If no water can be obtained near enough to supply the tender with buckets, help must be sent for; but if there is a well, stream, or pond of water near, the tender can be partly filled by carrying water.

QUESTION 863. *In case an engine becomes blockaded in a snow-storm with plenty of fuel, but runs out of water, what can be done?*

Answer. Snow should be shoveled into the tender and steam admitted through the heater cocks so as to melt the snow.

QUESTION 864. *If a locomotive without an injector should be obstructed in a snow-storm or in any other way so that it could not move, and therefore could not work the pumps, what should be done in case the water in the boiler should get low?*

Answer. The weight of the engine should be lifted off from the main driving-wheels and the coupling-rods disconnected from the main crank-pin, so that the main wheels can turn without moving the engine. These can then be run and the pumps thus be worked. The weight can usually be most conveniently taken off from the main wheels by running the trailing wheels on wooden blocks, and thus raising up the back end of the engine.

QUESTION 865. *If it is impossible, in a snow-storm or in very cold weather, to keep steam in the boiler without danger, what should be done?*

Answer. Draw the fire, blow all the water out of the boiler, empty the tanks, disconnect the hose, and slacken up the joints in the pumps and injector so that all the water in them can escape, and thus prevent them from freezing up.

(TO BE CONTINUED.)

Manufactures.

"Machined" Car Wheels.

THAT ordinary chilled cast-iron wheels are not true, and are not of uniform size, every master car-builder and every other person who has given attention to the subject knows only too well. The causes are numerous. In the first place the chill-molds in which the wheels are cast are not made of uniform size. One maker turns molds which are nominally of a given size, several eighths of an inch larger or smaller than his competitor does. Next, after an ordinary chill-mold has been in use for a longer or shorter time, it is liable to change its shape, by reason of the frequent and great changes of temperature to which it is subjected when in use—that is, after being used for a time, its interior surface, which forms the tread of the wheel, instead of being a true cylinder or a true frustrum of a cone, changes its shape more or less. There are abundant illustrations of this action of heat on castings. For example, a large slide-valve, if ground perfectly tight when it is new, is very liable to leak after it has been in use a short time and exposed to the heat of the steam. The same thing is true of the double puppet throttle-valves used on locomotives.

If, after being in service a short time, they are then reground, they are apt to stay tight. Malleable castings are nearly always more or less distorted in the annealing process. A ⅝ in. hardened steel cylindrical gauge and ring, belonging to the writer, which originally fit each other perfectly, after being exposed to the ordinary changes of temperature of the atmosphere, were found to have changed their form, and the plug was sufficiently loose in the ring, so that its "shake" could be felt perceptibly. It is believed that if the chill-molds of car-wheels were thoroughly annealed before they are turned, they would be much less susceptible to a change of form on account of the variations in temperature to which they are subjected.

This lack of mechanical veracity in chilled car-wheels has long been recognized, and, like many other forms of mendacity, has been deplored by those who are best acquainted with the evils that it entails.

The proprietors of the New York Car Wheel Works of Buffalo, N. Y., recognizing the impossibility of casting perfectly true wheels, turned their attention, recently, to methods of trueing them up after they are cast, at a cost which would not be a serious obstacle in the way of using such wheels. After some years of experiment they perfected a satisfactory machine for doing this work, and besides making the wheels, they are now prepared to supply them with their treads machined, so that their peripheries are true circles. The wheels are first bored, and are then placed on a self-centering mandrel, and the outer part or tread of the wheel is ground true. There is nothing novel in this excepting that this Company has erected a plant specially designed for this kind of work, and for doing it at a very low cost and in the best manner. They say that a variation of one sixteenth in boring a wheel doubles the cost of machining its tread. Their aim is to cast the wheels and bore them as true as possible. This reduces the cost of machining which with special machines can then be done very rapidly.

Marine Engineering.

THE *Columbia*, the latest addition to the Hamburg-American Line, made her first passage from Southampton to New York in 6 days and 23 hours, averaging 447 miles a day. The *Columbia*, which was built by the Laird Brothers, Birkenhead, England, is 470 ft. long, 56 ft. beam, 38½ ft. deep, and draws 24 ft. loaded, her displacement being about 10,000 tons. She is built of mild steel with double bottom, and is divided into 12 water-tight compartments. She has twin screws, each with an independent set of triple-expansion engines. The cylinders are 40 in., 66 in., and 101 in. in diameter, and 66-in. stroke. The propellers are 18 ft. diameter and 32 ft. pitch. Steam is furnished by six boilers 17 ft. 3 in. long, and 15 ft. 4 in. in diameter, and three boilers of the same length but 14 ft. 3 in. in diameter. The working pressure is 150 lbs., and the two engines have developed 13,500 H.P. together.

A BARGE on a new plan has been recently launched at Duluth; it is 260 ft. long, 36 ft. beam, and 22 ft. deep, and has a carrying capacity of 3,000 tons. It is built of steel with double bottom, is divided into water-tight compartments so arranged that one or more of them can be filled when the vessel is only partly loaded. The upper part of the barge has a sort of turtle-back deck, in order to offer the least resistance of the wind and avoid the danger of breaking loose from the tug during storms. It is intended to carry iron ore.

THE new steamship *Kansas City*, built by the Delaware River Iron Shipbuilding Company for the Ocean Steamship Company (New York-Savannah Line), was launched at Chester, August 10. The *Kansas City* will have a capacity of 6,500 bales of cotton and accommodations for 240 passengers; she is 346 ft. long, 45 ft. beam, and 27½ ft. depth of hold. She is built of steel throughout. The engines are triple-expansion, with diameter of cylinders respectively 33 in., 54 in., 86 in., by 54 in. stroke of piston. Eight return tubular boilers 12 ft. diameter by 11 ft. 6 in. long, each having two corrugated furnaces 48 in. in diameter, will supply the steam at a pressure of 160 lbs.

The propeller wheel is of the Hirsch pattern, with a mean pitch of 22 ft. 6 in. She is the tenth steamer built in the Roach yards for the Ocean Steamship Company.

A New Pneumatic Gun.

THE accompanying drawings show a new pneumatic piston gun for throwing shells loaded with high explosives. Fig. 1 is a section of the gun itself, and fig. 2 shows the method of compressing the air.

In fig. 1, which is a longitudinal cross-section of the gun, *A* is the air-compressing chamber having the sliding piston *B*, in the rear of which the explosive *C* (here represented as a blank cartridge) is inserted.

D is the barrel pivoted at *E* to the head-piece *F*, which closes the chamber *A*, and which is provided with the duct or passage *G* for the compressed air.

H is a lock for retaining barrel *D* in position after loading.

I is the mechanism, of well-known construction, for loading and firing the explosive, and *K* is a projectile.

The gun may be provided with trunnions, as shown.

The operation of the gun is as follows: Piston *B* having been pushed to the rear end of chamber *A*, as shown in the drawing, the explosive *C* and projectile *K* charged as shown, and barrel *D* locked in position, the explosive *C* is then discharged, driving piston *B* before it to the other extremity of the chamber *A*. The air compressed in front of piston *B* is conducted to the rear of the projectile in barrel *D*, where its expansion expels the projectile *C* from the barrel.

The head-piece *F* is shown in the drawing as screwed to the outside of chamber *A*; but it may also be screwed on the inside of the same, and the gun-barrel *D* may be made integral with the head-piece, in which case piston *B* would be pushed to its place and the projectile loaded from the muzzle of the gun without departing from the spirit of the invention, which consists, essentially, of an air-compression chamber adapted to contain

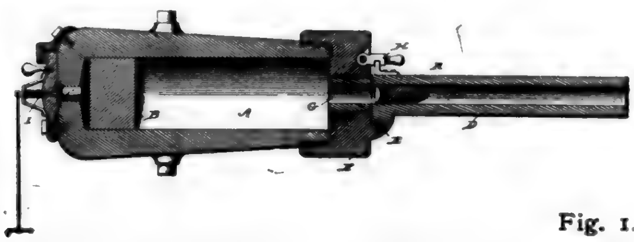


Fig. 1.

an explosive, a piston driven by the discharge of the explosive, a barrel or tube adapted to discharge a projectile, and means for communicating the air-compression produced by the piston to the projectile in the gun barrel or tube.

In fig. 2, which is a vertical cross-section of a mounted pneumatic gun, *A* is the air-compression chamber having a removable breech-piece *B*, of well-known construction, and provided with the firing mechanism *B'*.

C is the explosive.

D is a diaphragm of metal or other suitable material closing the end of the explosion-chamber and held in place by means of the cap *E E*, which screws onto and partly over the end of the air-compression chamber *A*. This diaphragm *D*, when thus secured in place, tightly closing the chamber *A*, acts as a pressure safety-valve, the resistance of the diaphragm providing one means for determining the degree of pressure that can be produced within the chamber.

F F is an air-tube open at both ends, which connects the compression-chamber *A* with the barrel *G* of the air-gun in the rear of the projectile *H*, as shown.

I is the breech-piece, removable for the purpose of inserting the projectile. *K K* are braces to hold the parts together.

The gun having been loaded, as shown in the drawing, with the projectile in barrel *G* forward of the entrance of the air-tube and the explosive in chamber *A*, the breech-pieces *B* and *I* are closed and diaphragm *D* firmly secured in place. On the explosion of the explosive *C* by means of the primer *B'*, or in any other well-known way, the contained air is at once greatly compressed, and this pressure, communicated through tube *F* to the rear of the projectile in barrel *G*, discharging the gun.

A gun of the following dimensions will give good results, illustrating the application of the process to a pneumatic gun, in which the diameter of the bore proper (barrel *G*) is 1¼ in.; length, 84 in.; diameter of air-tube (tube *F*) is 2 in.; length, 40 in.; diameter of air-compression chamber *A* is 3 in.; length, 38 in.; weight of projectile is two pounds; of powder-charge, eight ounces; and the resistance of plate *D* to blowing out, 45 lbs. per square inch.

Gas or gases of greater or less density as well as air may be used without departing from the spirit of this invention.

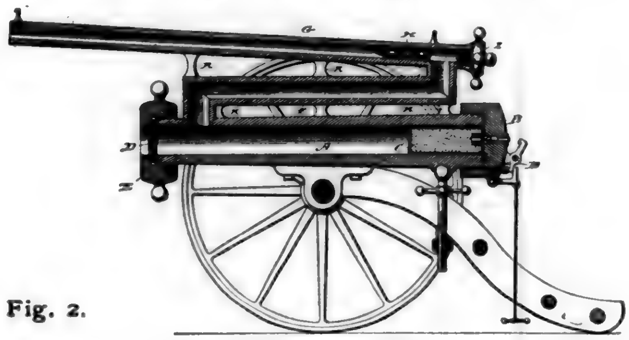


Fig. 2.

The essence of the invention consists in the production of an air-pressure by means of an explosive, which air-pressure may afterward be utilized in discharging a projectile.

This invention is covered by patents Nos. 407,474; 407,475, and 407,476, granted to Dana Dudley, and by him assigned to the Hotchkiss Ordnance Company.

Electrical Notes.

THE West End Railroad Company, which operates nearly all the street lines in Boston, has voted to increase its capital stock to $4,500,000, in order to introduce the electric system on its various lines. The system used will be the overhead wire, and this action is taken in consequence of experiments on its Arlington and Allston lines, and on the Cambridge and Brighton branches.

THE Safety Light & Power Company has commenced the erection of an extensive station in New York. This company will operate the Westinghouse alternating system, and the power for running the dynamos will be furnished by six Westinghouse compound engines, each of 150 H.P.

Cars.

THE Indianapolis Car Company is building 500 coal cars for the Missouri, Kansas & Texas Railroad.

THE new shops of the Minnesota Car Company at Duluth, Minn., are completed, and will soon be at work. They will have a capacity of 15 box cars a day.

THE Pennsylvania Railroad Company's recent large order for the building of freight cars has been distributed as follows: Altoona shops, 1,000 cars; Peninsular Car Company, Detroit, 500; Murray, Dougal & Company, Limited, Milton, Pa., 400; Pardee, Snyder & Company, Watsontown, Pa., 200; Erie Car Works, Erie, Pa., 300; Harrisburg Car Company, 200; Michael Schall, York, Pa., 100; Schall & Shoop, Dauphin, Pa., 100; Carlisle Manufacturing Company, Carlisle, Pa., 200 cars. Most of the cars are hopper gondolas.

MOST of the car works in Pennsylvania are busy with orders. The Lebanon Manufacturing Company has recently shipped 210 new 60,000-pound cars to the George's Creek & Cumberland Railroad, 250 coke cars to the Bell's Gap Railroad, and 100 coal cars to the Westmoreland Coal Company. The Jackson & Woodin Manufacturing Company, of Berwick, Pa., is building 50 hopper-bottom coal cars for the Delaware, Lackawanna & Western Railroad, and 400 cars for the New York, Susquehanna & Western Railroad. The Harrisburg Car Company has recently taken orders for 400 oil-tank cars for private shippers.

ORDERS for freight equipment recently placed by the Northern Pacific are among the heaviest of the year. The cars just ordered are of four classes, and aggregate 2,400, in addition to the orders placed earlier in the season for 500 furniture cars. Of these, the Peninsular Car Company, of Detroit, Mich., is building 400, and the La Fayette Car Company, of La Fayette, Ind., 100. The orders just placed are distributed as follows: Peninsular Car Company, Detroit, 370 box, 300 stock, 300 flat, and 300 gondola coal; Barney & Smith Manufacturing Company, Dayton, O., 430 box; United States Rolling Stock Company, 350 box; Wells & French Car Company, Chicago, 350 box.—*Northwestern Railroader.*

THE Centropolis Car Company, Centropolis, Kan., has just completed its works. The foundry has been running some time.

THE Dunham Manufacturing Company, Boston, has recently received orders for 2,000 of its freight-car doors.

SINCE the commencement of the year the Richmond & Danville has given out contracts for building 2,150 cars. A large number of these have been delivered, and it is expected to have them all delivered by October 1. The contracts were let as follows: To the Pullman Company, 420 box cars; to the South Baltimore Car Company, 560 box and 200 stock cars; to the Tredegar Company, 300 cars; to the United States Rolling Stock Company, 500 double-hopper coal cars, 100 coke, and 70 platform cars. All the box and stock cars will be equipped with air brakes and M. C. B. Standard couplers, and the open cars will be equipped with M. C. B. couplers. Four hundred of the box cars and all the open cars will be of 60,000-lbs. capacity. The balance of the cars will be 40,000-lbs. capacity.

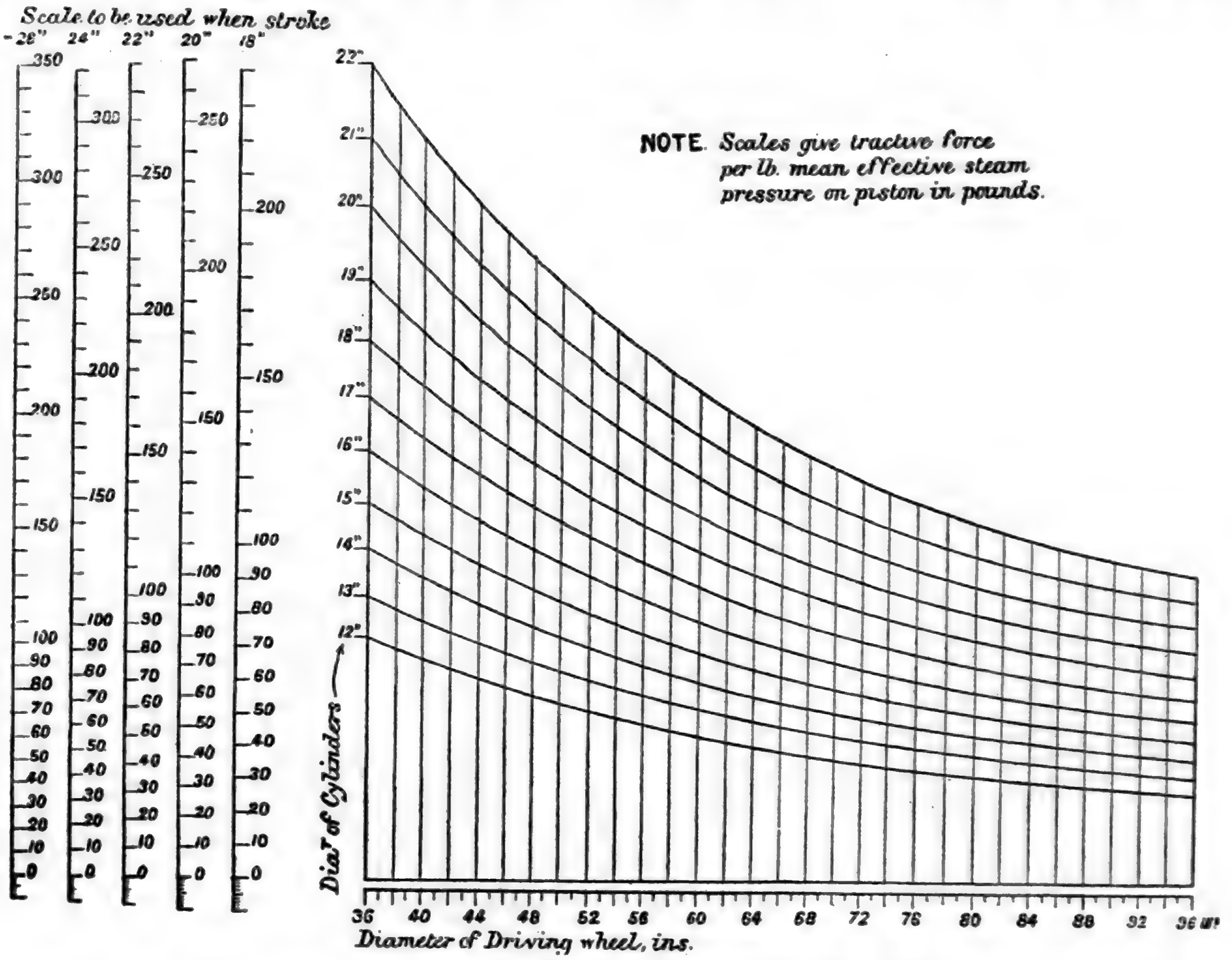
THE Litchfield (Ill.) Car Company is building 300 box cars for the Denver & Rio Grande and 200 refrigerator cars for the Cairo Short Line.

IT is reported that the Pennsylvania Railroad Company will try the Ford passenger car, the body of which is built entirely of steel.

Tractive Power of Locomotives.

(From the London *Engineer*.)

THE diagram herewith gives the tractive power, in pounds, of locomotives per pound mean effective steam pressure on piston, and is one which will be found very useful in solving all questions relating to size of cylinder for given tractive power, length of stroke, maximum diameter of driving-wheels, etc., and also for facilitating the comparison of the tractive power of different engines. As an example of the use of the diagram, suppose we require to know what will be the mean tractive power of an engine having cylinders 17 in. diameter by 22 in. stroke, and driving-wheels 60 in. diameter. At the point marked 60 in. on the scale of diameters of driving-wheels at the bottom of the diagram, with a pair of dividers measure the length of the ordinate from the base line up to the line marked 17 in. diameter, transfer this to the scale to be used when length of stroke equals 22 in., and read off 106 lbs. as the tractive force which will be exerted for every pound mean effective pressure on the piston, or $\frac{17^2 \times 22}{60} = 106$. Again, given the diameter of driving wheels, length of stroke, and tractive power, required the diameter of cylinders: Reduce the tractive power to pounds per pound of mean pressure, and taking this value on the scale to be used for the given length of stroke, set it off over the given diameter of wheels, and read off the diameter of cylinders required. Other uses of the diagram will readily suggest themselves to locomotive engineers.



Manufacturing Notes.

THE Dunham Manufacturing Company, Boston, reports an order from the Rio Grande Western Railroad for Servis tie plates to equip 40 miles of road; also large orders from the Missouri Pacific and the Northern Pacific.

THE Westinghouse Machine Company, Pittsburgh, report a large number of orders for their compound engines, ranging from 35 to 250 H.P. The works are running extra time to fill orders. In addition to the large sizes, a number of small compound engines are being sold, and the Company is making patterns for these engines down to as small as 3 H. P.

THE Pond Machine Tool Company, New York, has just received an order from the New York & New Haven Railroad for a steel tire turning lathe, for turning steel wheels on the axles; this machine weighs about 23 tons and permits the use of a broad-faced tool, taking the entire tread of both wheels at one cut. Several of these lathes are already in use on different roads. The Company is also building for the same road a 79-in. driving-wheel lathe with double quartering attachment.

THE modern plan of subdividing steam power—in other words, the primary transmission of power from the boiler to

the work by means of steam pipes in place of belts and shafting, is rapidly growing in favor. Westinghouse, Church, Kerr & Company are now fitting up the plant of the Long Island Railroad at East New York, using, in place of a single engine, three engines of 75, 60 and 25 H.P., respectively.

Locomotives.

THE Rhode Island Locomotive Works, in Providence, are building 12 consolidation locomotives for the Fitchburg Railroad and 2 eight-wheel engines for the East & West Alabama; also a fast freight engine and a Forney engine for suburban traffic for the New York, Providence & Boston Railroad.

AMONG other orders at the Baldwin Locomotive Works, Philadelphia, are 25 freight engines for the Texas & Pacific, and 19 for the Atlantic Coast Line.

THE New York Central & Hudson River Railroad is about to let contracts for 56 new locomotives. The number will include 50 freight engines, with six wheels coupled, and cylinders 19 × 26, weighing 60 tons each; five passenger engines for local service on the Harlem Division, ordinary American type, 17 × 24 in. cylinders, weighing 42½ tons each; and one dummy engine, for hauling freight on the New York City street tracks. —*National Car-Builder.*

THE Pittsburgh Locomotive Works are building several engines for the Richmond & Danville Railroad.

THE New York Locomotive Works, Rome, N. Y., are building 7 consolidation freight engines for the New York & New England Railroad.

An Electric Mine Locomotive.

THE accompanying illustration (from *Industries*) shows an electric locomotive built by Immisch & Company, London, England, for the Wharncliff-Silkstone coal mine. It runs on a line of 21-in. gauge, the mine tunnel being 4 ft. high by 4 ft. 6 in. wide, and its total weight is 2½ tons. Fig. 1 is an elevation and fig. 2 a plan of the engine.

The frame of the locomotive is supported on springs on axle boxes outside the wheels, and in order to secure a maximum degree of steadiness, four sets of storage cells have been suspended in front and rear of the wheels from the platform. The wheels are coupled by rods to fully utilize the weight for adhesion.

The storage battery consists of 44 modified Tatham cells, each box being 10 in. by 6½ in. by 11 in. high. The boxes are lead lined, and arranged in sections of three in wooden trays. Each box contains 19 plates, 7 in. by 4½ in. by $\frac{3}{32}$ in. thick, and has a capacity of 150 ampère-hours, the weight being 53 lbs. The rate of discharge varies between 25 and 50 ampères, and at starting rises occasionally to 65 ampères. Taking 40 ampères as the average rate, the weight of these cells per H.-P. works out to nearly 500 lbs.; and per H.-P. hour storage capacity to 134 lbs. Messrs. Immisch & Company state that they are now engaged in working out several improvements, by which the storage capacity, as compared to weight, will be increased. The motor, which is placed underneath the platform and between the wheels, is of the ordinary Immisch type. The armature is 10 in. diam., and wound with No. 12 S. W. G. wire. There are 480 wires counted around the periphery, and the commutator has 48 sections. The resistance of the armature is 0.23 ohm. The field is of the double horseshoe type, and wound with No. 9 S. W. G. wire in two parallels, there being 560 effective turns. The resistance is 0.14 ohm, or total resistance of the motor 0.37 ohm. The normal current is 45 ampères, and the speed 1,000 revolutions per minute, with a terminal pressure of 100 volts. The weight of the motor is 450 lbs., and

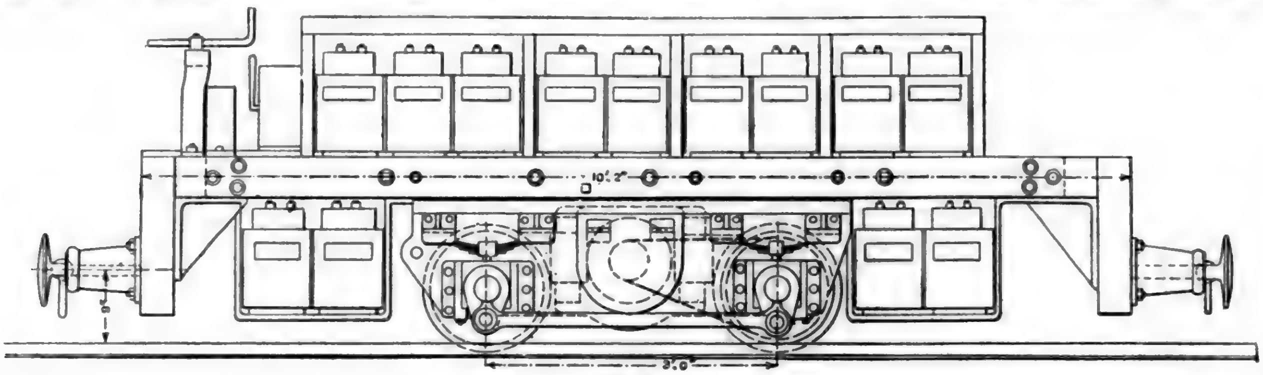


FIG. 1

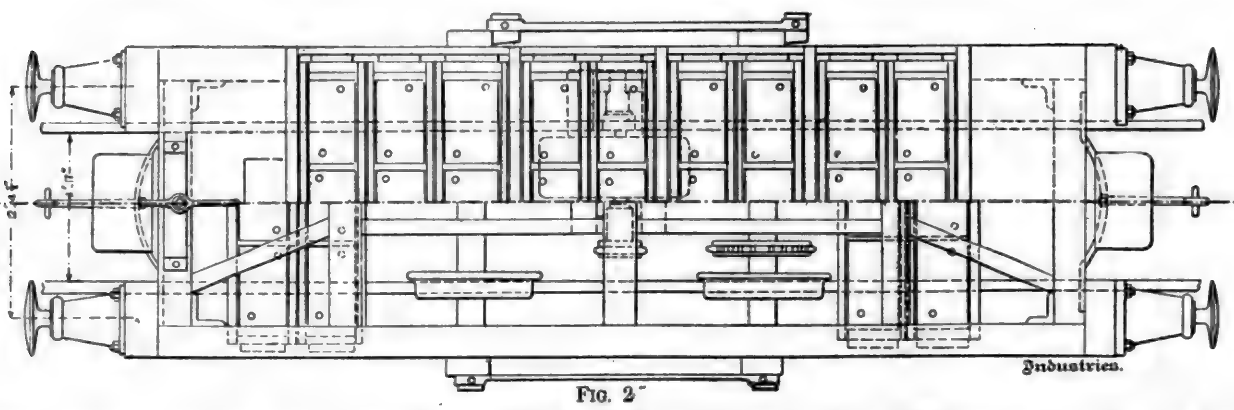


FIG. 2

it gives 4 H.-P. at 800 revolutions per minute. On the armature spindle is a small phosphor bronze pinion; this gears into four steel pinions, placed in the same plane, and 90° distant from each other. These pinions are bushed with gun metal, and run on steel pins carried on a cast-iron disk. The disk revolves on a journal turned outside of the end of the motor bearing. Outside of, but in the same plane as these pinions, is fixed an annular casting of gun metal, with teeth cut on the inside. The steel pinions gear into the ring, which forms a fulcrum on which they revolve when the motor spindle turns. The power is transmitted from the cast-iron disk by a sprocket pinion keyed to it on the inside next the motor, and a steel chain connects this sprocket pinion to a suitable wheel mounted on one of the axles, while the other axle is connected with this by the coupling rods already mentioned. The direction of motion is reversed by a switch, which reverses the magnetization of the field, and the speed is regulated by iron resistance coils. A brake is also provided. The current for charging the battery is furnished by an Immisch dynamo, which is driven by belt from a Willans engine.

Some trials of this engine were made on a surface line at the colliery, before it was put at its regular work in the tunnel. This line was 3,000 ft. long, having, in the order stated, 600 ft. level; 600 ft. grade 1 in 70 (75 ft. per mile); 450 ft. grade 1 in 40 (132 ft. per mile); 750 ft. grade 1 in 25 (211.2 ft. per mile, and 600 ft. grade 1 in 40). At the trial, on the grade of 1 in 70 the locomotive would just move a train of 20 loaded mine cars, weighing together 11 tons, and with 15 cars, representing 8¼ tons, a speed of three miles an hour was obtained, the current being 45 ampères at 100 volts pressure. On the grade of 1 in

40 the maximum load was eight cars, and on 1 in 25 it was six cars, the speed being a little over two miles an hour. On the level the locomotive could draw 30 cars, the current being 45 ampères.

Steel and Iron.

THE well-known firm of Hoopes & Townsend, Philadelphia, have purchased the entire plant of the Hare & Morgan Company, of Wilmington, Del., and will operate it under the name of the Hoopes & Townsend Company as an addition to the works in Philadelphia.

THE first cast of open-hearth steel was made at the Latrobe Steel Works, at Latrobe, Westmoreland County, Pa., on Wednesday, August 7, one of the 15-ton furnaces having been completed. Another furnace of the same size will be completed soon. This is a wholly new plant, the building of which was commenced in 1888. The product of the open-hearth plant will be rolled into tires for locomotive and car wheels. The branch office of the works is at No. 251 South Fourth Street, Philadelphia. The officers are: Marriott C. Smyth, President; Walter H. Bryant, Secretary; Ellwood W. Kimber, Treasurer; Guilliaem Aertsen, Manager; Julian Kennedy, Chief Engineer; J. K. Griffith, Superintendent.

THE National Tube Works Company, of McKeesport, Pa., have been awarded a contract for 80 miles of 12 and 16-in. pipe, to be used by the Northwestern Ohio Gas Company on their projected line from their Ohio field to Detroit. The contract amounts to $800,000.

THE Bookwalter Steel & Iron Company, 18 Cortlandt Street, New York, owners of the Bookwalter-Robert process for the manufacture of steel, have been advised that the exhibit of this process in the Paris Exposition was awarded the highest gold medal and an additional prize of 14,000 francs. John Brown & Co., of Sheffield, have taken a license to operate under these patents from the English company controlling the patents for that country. The Michigan Steel Works, at Detroit, are now in operation under this process.

THE Standard Steel Casting Company, Thurlow, Pa., is the only company which so far has put in a bid for furnishing to the Government 100 7-in. and 100 11-in. steel shells. Their bid is: Seven-in. shells, $66.85 each; 11-in. shells, $135 each. No award has been made.

THE Reliance Steel Casting Company is the name of a new company recently organized at Pittsburgh to engage in the manufacture of steel castings. It is at present erecting a building 50 × 135 ft. in that city. Charles Bailey, who was for some years Assistant Superintendent of the Pittsburgh Steel Casting Company, is chairman of the new company.

THE War Department has awarded the contract for furnishing castings and forgings for a 10-in. rifle to the Standard Steel Casting Company of Thurlow, Pa., at 27 cents per pound. The contract for furnishing the army with forgings for three hoops and parts of breech mechanism for a 10-in. steel wire gun has been awarded to the Bethlehem Iron Company, of South Bethlehem, Pa., at 40 cents per pound for certain of these forgings, and $1 per pound for the breech mechanism forgings.

THE Seattle Iron & Steel Manufacturing Company, of Seattle, Washington Territory, has been organized. The capital stock will be placed at $100,000, and may be increased to $500,000. The works will be built at Salmon Bay, near Seattle, where the company has purchased 20 acres of land adjoining the Seattle, Lake Shore & Eastern Railroad tracks.

Bridges.

WORK is in progress at Messrs. A. & P. Roberts & Co.'s Pencoyd Iron Works on the superstructure of the new bridge which is to cross the Schuylkill River at the Falls of Schuylkill, Philadelphia, to connect the Philadelphia & Reading Railroad Company's main line with the Port Richmond Branch, to accommodate the Baltimore & Ohio through trains to New York. The bridge is to be of iron, resting on stone piers and approaches, and will be a plate-girder bridge.

THE Wrought Iron Bridge Company, of Canton, reports a heavy business. Among its late contracts is the building of the second viaduct for the Denver City Cable Railway Company, at Denver, Col., to be 3,000 ft. long; they now have under way a like viaduct 2,800 ft. long for the same company; four new steel bridges and the repair of the fifth one in Wood County, W. Va., destroyed by the recent floods.

THE Smith Bridge Company, Toledo, O., has been awarded the contract for building the bridge over the Tennessee at Chattanooga, Tenn. Neely, Smith & Co., of Chattanooga, were awarded the contract for the substructures. The contract for the superstructure was let at $122,361, and for the substructure at $96,198. The bridge will be 2,370 ft. long, and will be 100 ft. above low-water mark, obviating the necessity for a draw.

THE Allentown Rolling Mill Company is building a bridge over Jordan Creek, in Allentown, Pa. It is a plate-girder span, 93½ ft. long.

OBITUARY.

ISAAC PRATT CHAMBERS, who died in Saratoga, N. Y., August 16, aged 53 years, was born in Malden, Mass., and entered the office of the Hudson River Railroad Company as a boy of 19 about 34 years ago. In 1864 he was placed in charge of the New York offices; in 1872 he was appointed Auditor of the New York Central & Hudson River Company, and in 1883 General Auditor and Controller. For some years also he acted as Secretary to the President. Mr. Chambers was one of the best railroad accountants in the country, and was considered a high authority on all questions of railroad business and traffic.

WILLIAM THAW, who died in Paris, August 17, aged 71 years, was born in Pittsburgh. He began business in his father's bank in 1834, and eleven years later formed a partnership with Thomas S. Clarke, as Clarke & Thaw, transporters and owners of steam and canal-boats. This was continued until the Pennsylvania Railroad was built. Subsequently he became connected with that road and held various official positions. For a number of years past he had been Vice-President of the Pennsylvania Company. Mr. Thaw leaves a very large fortune; he was the largest individual stockholder in the Pennsylvania Railroad Company.

PROFESSOR ELIAS LOOMIS, who died in New Haven, Conn., August 14, aged 78 years, was born in Willington, Conn., and graduated from Yale College in 1830. Three years later he became a tutor in the college. During this period, conjointly with Professor Alexander C. Twining of West Point, he began the first observations in this country to determine the altitude of shooting stars. His first distinct mark in the field of science was made in 1835, while still a tutor at Yale, when, computing the elements of its orbit from his own observations, he discovered Halley's comet on its return to perihelion. A year later he studied at Paris under Arago, Biot, Pouillet, and others. Until 1844 he was Professor of Mathematics and Natural Philosophy in the Ohio Western Reserve College. From that date until 1860 he occupied the chair of Natural Philosophy in the University of the City of New York, which gave him his degree of LL.D. in 1854. In 1873 he was made a member of the National Academy of Sciences. His name was also a distinguished one on the rolls of the different scientific societies of America and Europe.

Professor Loomis is widely known by his series of text-books, embracing the whole scope of mathematical subjects. These became class books in high schools and colleges all over the land. He was also the author of popular treatises on natural philosophy, astronomy, and meteorology. Many of his treatises took the form of contributions to the different scientific publications in this country and in Europe. Not the least work performed by the famous mathematician was his comparison from 1846 to 1849 by telegraph of different longitudes, and also his successful observations determining the velocity of electric fluid on telegraph wires.

PERSONALS.

WILLIAM M. GRAFTON has been appointed Signal Engineer of the Pennsylvania lines west of Pittsburgh, with office at Pittsburgh. This is a new office.

LIEUTENANT J. G. CALIFF, U.S.A., has been relieved from duty as Professor at the State University of Iowa, and ordered to join his regiment, the Third Artillery.

ALEXANDER C. CHENOWETH has been appointed Assistant Engineer in the Public Works Department of New York City, in place of SAMUEL L. COOPER, resigned.

CHARLES S. WRIGHT, Chief Engineer of the New Orleans, Fort Jackson & Grand Isle Railroad, has been made Superintendent, in addition to his present duties.

J. A. FULTON has resigned as Bridge Engineer of the Toledo, St. Louis & Kansas City Railroad, and accepted a similar position on the Lake Shore & Michigan Southern.

FRANCIS F. R. BROWN has resigned the position of Mechanical Superintendent of the Canadian Pacific to become Superintendent of the Dominion Bridge Company, Montreal.

W. H. PRATT, C.E., recently resigned his position with the Edge Moor Bridge Works to become Superintendent of the Mount Vernon Bridge Company's works at Mount Vernon, O.

E. W. GRIEVES is now Master Car-Builder of all the lines of the Baltimore & Ohio Railroad Company. Heretofore he has had charge of the Car Department of the lines east of the Ohio River.

ENSIGN GEORGE W. STREET; ENSIGN JOHN G. TAWRESEY and ASSISTANT ENGINEER LLOYD BANKSON have resigned their respective positions, and have been appointed Assistant Naval Constructors, dating from July 1.

EDWARD F. HOBART, of Las Vegas, N. M., who has been appointed Surveyor-General of New Mexico, is a civil engineer by profession and assisted in the construction of some of the early Western roads, including the old Racine & Mississippi Railroad, now a part of the Chicago, Milwaukee & St. Paul system.

CAPTAIN EDMUND L. ZALINSKI, Fifth Artillery, now abroad, has been detached for a period of four months to obtain military information, under such instructions of the Secretary of War as may be communicated to him. He will return to the United States and rejoin his proper station upon the completion of these duties.

IT is stated that JOHN KIRBY, General Master Car-Builder of the Lake Shore & Michigan Southern, has resigned, and that he will be succeeded by JOHN PATTERSON, late Master Mechanic of the Cincinnati, Indianapolis, St. Louis & Chicago. Mr. Kirby resigns, we understand, with the purpose of retiring from railroad work.

CAPTAIN ERNEST H. RUFFNER has been appointed Major in the Engineer Corps; FIRST LIEUTENANT THEODORE A. BINGHAM to be Captain; SECOND LIEUTENANT MASON M. PATRICK to be First Lieutenant, and CADET E. E. WINSLOW to be Second Lieutenant. These promotions have been made in consequence of the retirement of Colonel John G. Parke.

LIEUTENANT R. P. RODGERS, U.S.N., will shortly be relieved from duty as Chief Intelligence Officer of the Navy Department, and ordered on sea service. He has had charge of the Bureau of Naval Intelligence for four years past, and it is largely due to his thorough and intelligent supervision that the work of the bureau has been systematized, and its publications made to command general attention.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—The following circular has been issued by the Secretary:

"I am directed to issue for the information of all concerned the following documents, viz.:

"1. Report of the Special Committee on Uniform Standard Time, presented at the last Annual Meeting of the Society.

"2. List of railway presidents, managers, superintendents, engineers and others, who have at different times given expression in favor of the 24-hour notation.

"The Committee requests me to add:

"The report explains the progress made up to the present time in the movement for the adoption of the 24-hour notation. It is felt that the information is of sufficient importance to be made generally known, especially to railway men throughout the country.

"The question may not appear of pressing importance to any single individual, but, taking into consideration the countless millions of people in all future time to be benefited by the successful adoption of the new notation of the hours of the day, attention to the report is respectfully invited.

"In promoting the movement for reforming our system of reckoning time, in order to secure uniformity, simplicity, and accuracy, the American Society of Civil Engineers requests the sympathetic co-operation and assistance of all who are favorably disposed. Every man has it in his power to influence the movement; even a simple expression of opinion in its favor will do so. All, therefore, who may be so inclined, are invited to fill up the accompanying form and transmit it to the Committee, care of the Secretary."

(The report of the Committee, referred to above, was published in the JOURNAL for May last, page 225.)

Engineers' Club of Cincinnati.—At the 13th regular meeting of the Club there were 31 members present, also two visitors. Two applications for membership were received.

The paper for the evening was by Mr. Ward Baldwin, under the title of "The Method of Calculating Bridge Strains for a Concentrated Rolling Load," in which he presented a review of a method of using a graphical diagram for ascertaining the strains induced in simple girders and trusses by the now almost universally specified rolling-load for railroad bridges, by which method a considerabe saving is made in the calculations required and the work much simplified.

The Club adjourned to meet again in September.

Western Society of Engineers.—At the regular meeting, held July 10, the following persons were elected to membership: Andrew Onderdonk, Max J. L. Towler, H. Russell Smith, H. A. Stoltenberg and A. Bertolet.

Messrs. L. E. Cooley and E. C. Carter were appointed as a committee to prepare a memorial of Mr. Robert G. Turknett, a deceased member.

An interesting letter from Mr. Walter Katte, Chief Engineer of the New York Central, detailing his first connection with the Society, which dates from before the Chicago fire, was read.

After an informal talk on the matter of questions for discussion, the Chairman gave notice that at the next meeting, to be held September 4, the following questions would be before the meeting:

1. As a means of rapid transit, for the older portion of Chicago, would not underground electrical railroads be profitable?

2. Systems of municipal engineering in very large cities.

A paper descriptive of compound lumber will also be read at that time, by G. A. M. Liljencrantz.

Denver Society of Civil Engineers.—At the regular meeting August 13, James Philips Maxwell and John Wellington Nesmith were chosen members. A communication from a committee of the American Society of Civil Engineers asking for the appointment of a committee to confer on the question of affiliation between the Societies was received; Professor P. H. Van Diest, H. T. Aulls, and Robert S. Rochlaub were appointed such a committee.

Messrs. J. R. Maxwell, J. S. Green, Walter H. Graves, R. D. Hobart, and J. C. Ulrich were appointed a committee to act in collecting statistics and presenting facts to the United States Senate Committee on Irrigation on its visit to Denver.

Professor P. H. Van Diest read a paper on Mining in the Island of Sumatra. The mines were opened by the Dutch 250 years ago, but have not been worked for 100 years past, although rich returns were formerly made. Recently a company has been organized to reopen them. The paper was accompanied by maps and diagrams.

Interstate Commerce Commission.—The following circular was issued by the Commission, addressed to all organizations of railroad employés, under date of August 1:

"A knowledge of the facts regarding the relations which exist between the railway corporations and their employés is always of public importance, and may be particularly useful to the Commission in some cases in order to enable it to perform its duties in such manner as best to subserve the interests involved. Believing, therefore, that you will willingly co-operate in obtaining the facts, you are respectfully requested to transmit to this office a reply to the following questions:

"1. Is there an insurance fund, guarantee fund, or any other fund from which the members of your order may receive payment in case of sickness, or accidental injury, or from which their families may draw in case of death? If such fund exists please state when it was established, and whether by the railroad corporation or the employés; how it is accumulated; how maintained, and give any other facts that may be important to a full understanding of its history and workings. If no such fund exists, please state if its establishment was ever attempted; if so, to what extent, if at all, the attempt succeeded, and why it failed.

"2. Does your order insist upon any rules of apprenticeship, and if so, what are they? If a fireman or brakeman can only become engineer or conductor after a term of service, please state what that term is.

"3. In the case of engineers and conductors, are their grades of service recognized either by the order to which the employés belong or by the employing company? If so, what are those grades; and what are the conditions for passing from one to the other? In the case of men engaged in shop work, are promotions made from the ranks of the employés, or are men brought from the outside to fill the positions of foremen and the like? If no recognized custom exists, please state whether it has been the subject of discussion hitherto, and what have been the impediments, if any, to its establishment. Copies of papers or documents bearing upon these questions and calculated to elucidate the subjects will be thankfully received."

At the same time the Commission issued also the following circular, addressed to general managers of railroads:

"All facts regarding the relations existing between railway corporations and their employés are always of public interest, and may be of importance in determining questions upon which the interest of the employers as well as of the employed may depend.

"The Commission therefore address to you the following inquiries, believing that you will appreciate the purpose of the call, and that you will cheerfully render any assistance that may be within your power to facilitate the gathering of the information which they are designed to elicit:

"1. Is an insurance fund or guarantee fund of any sort provided for the employés of your company on which they have a right to draw in case of sickness or accident, or from which payment may be made to their families in case of death? If such fund exists please state in what manner it was accumulated; how it is maintained; under whose direction it is administered; under what conditions money may be drawn from it, and any other facts respecting it which you may think it important to state. If there are any contracts or other writings or printed documents which will give definite information, and which are in your possession, the Commission would be pleased to receive copies thereof. Please also state the length of time the fund has been established; the reasons which have led to its establishment, and the feeling in respect to it on the part of the employés. If no fund of the sort named exists, please state if any attempt has ever been made to establish one, to what extent, if at all, the attempt succeeded, and why it failed.

"2. Has the company eating or lodging houses for trainmen when away from home, or does it provide reading-rooms or other places of resort? If so, full particulars will be duly appreciated.

"3. Is any provision made by your company for technical education in your shops whereby it seeks to train men for its service? Is there any recognized system of promotion in the service of the company whereby it may be expected the men will be induced to labor for marked efficiency? Are any special rules in force to insure the competency of locomotive engineers and other trainmen?

"Should your own information on any of these subjects be defective, please give the names and addresses of any persons connected with your company who may be able to supply any deficiencies."

Master Mechanics' Association.—The following circular has been issued by Secretary Angus Sinclair, from his office 140 Nassau Street, New York City:

"Below is a list of the Committees appointed by President Briggs to carry on the work of investigation and other business during the year. The name first mentioned is Chairman of each committee. One Associate Member has been placed upon each committee, and it is expected that these will use their efforts to obtain scientific data and to furnish information that may be obtained outside of railroad sources. The Chairman of the various committees are urged to organize the work to be done by the different members, and begin the investigations assigned to them as early as possible, that valuable reports may be prepared in good season for the next Convention. The work of the Twenty-second Convention was greatly facilitated by most of the reports being delivered early.

"1. Exhaust-pipes, nozzles, and steam passages; best form and size in proportion to cylinders. Committee, C. F. Thomas A. W. Gibbs, Ross Kells and John A. Hill.

"2. Compound locomotives; their efficiency as compared with simple engines. Committee, J. Davis Barnett, John Player, H. D. Garrett and F. W. Dean.

"3. Testing laboratories, chemical and mechanical. Committee, Philip Wallis, George Gibbs, G. W. West and D. L. Barnes.

"4. Efficiency of the link, as compared with other valve motions. Committee, James M. Boon, David Clark, H. Tandy and John A. Coleman.

"5. Advantages and disadvantages of placing the fire-box above the frames. Committee, Fred B. Griffith, James Macbeth, W. A. Foster and L. F. Lyne.

"6. Relative value of steel and iron axles. Committee, John Mackenzie, J. S. Graham, John S. Cook and Thomas Shaw.

"7. Brick-arches in locomotive fire-boxes. Committee, T. W. Gentry, Allen Cooke, L. C. Noble and W. A. Smith.

"8. The best means, and the economy of preserving locomotive tanks from corrosion. Committee, W. J. Robertson, Albert Griggs, O. Stewart and Jerome Wheelock.

"9. Purification or softening of feed-water. Committee, W. T. Small, Harvey Middleton, A. W. Quackenbush and John W. Hill.

"10. The best form and size of axles for heavy tenders. Committee, W. Swanston, W. Garstang, James Maglenn and L. R. Pomroy.

"11. The present status of the automatic car-coupler question; and whether this Association can indorse the action of the M. C. B. Association in recommending the vertical plane type as a standard, from a mechanical standpoint. Committee, John Hickey, G. W. Rhodes, Sanford Keeler and M. N. Forney.

"Obituary of George C. Watrous. Committee, C. E. Smart, T. J. Hatswell and S. D. Bradley.

"Obituary of S. W. Haines. Committee, L. H. Turner, William Flahaven and E. Richardson."

Master Car & Locomotive Painters' Association.—The Twentieth Annual Convention will be held in Chicago, beginning September 11 next, and continuing probably three days. The Tremont House will be the headquarters of the Association. A special invitation is extended to car and locomotive painters to join in the Convention, and to become members of the Association. Among the subjects upon which reports are to be made by committees are: Painting the Heated Parts of Locomotives; Inside Finish for Passenger Cars; Filling for Driving Wheels and Other Rough Castings; the Use of Rubbing Varnish on Cars; Paint and Varnish for Locomotives; Decoration of Locomotives; Formula for Painting the Outside of Passenger Cars.

A number of questions will be submitted for general discussion, including the Treatment of Hard and Soft Woods; Color for Locomotives; Removing Old Paint; Prevention of Rust, and other similar queries.

Master Car-Builders' Association.—Secretary John W. Cloud has issued from his office in Buffalo a circular calling on members to vote on the questions referred to letter-ballot at the Saratoga Convention.

The questions thus submitted to vote are: Journal Box Lid; Wheels, Specifications, and Guarantee; Axle for Cars of 60,000-lbs. Capacity; Brake-gear for Air-brake Cars and Brake-shoe for Iron Beam; Buffers and Carrier-irons for the M. C. B. Type of Coupler, and Length of Draw-bar.

NOTES AND NEWS.

New Ship-Building.—The *Nautical Magazine* has prepared elaborate tables from the reports made to *Lloyd's Register*, showing the number of vessels built last year. There were launched in 1888, 765 vessels, having a total tonnage of 926,523 tons, being an increase of about 16 per cent. over the previous year. Of these vessels 548, with a total tonnage of 788,655, were steamers. England led here, having built 422 steamers with 699,613 tons. Germany was second with 33 ships, and a total of 33,834 tons, and the United States third, with 28 steamers of 15,496 tons. Of new sailing vessels, there were 217 built, having a total tonnage of 137,868. Here, again, England led with 62 ships of 77,380 tons, while the United States came second, with 45 vessels with 22,702 tons. It may be noted that while the average tonnage of the steamers built last year showed an increase of 8½ per cent. over the previous year, the average tonnage of the sailing vessels was nearly the same.

As to material, of the total number of vessels built last year, 451 were of steel, 106 of iron, 203 of wood, and 5 composite. The wooden vessels were chiefly sailing vessels, only 48 of the steamers being of that material, while 408 were of steel and 88 of iron. The chief builders of wooden sailing vessels were the United States, Canada, and Norway, while Great Britain, Germany, and France were the three leading builders of steel and iron ships, Great Britain standing very far in advance of the others.

The most notable feature is the great increase in the number of steel ships, from which it would appear that steel is very rapidly taking the place of iron as a ship-building material.

It seems apparent that there is a renewed activity in ship-building, and that the depression in that industry which has existed for several years is passing away. Whether this is to be followed by another period of low freights and depression remains to be seen.

The Hydraulic Railroad.—This is a novelty attracting much attention at Paris just now. It is the development of an old project of Girard, the well-known French hydraulic engineer. The trains are without locomotives and the carriages without wheels, being supported on broad rails raised some distance above the ground by metal blocks. Before the train is set in motion water under pressure is forced through valves in these bearing blocks, so that the latter are lifted off the rails and are carried on a thin film of water. The same agency is employed to propel the trains, a pipe, conveying water under pressure, being laid in the center of the track; from this pipe at short intervals rise stand-pipes with peculiar shaped nozzles controlled by a tap. Beneath each carriage is a long frame in which are a number of pallets, the surface of which can be acted on by the jet escaping from the nozzles. The action is extremely simple; the train being water-borne, and, therefore, having its friction reduced to a very great extent, is set in motion, and as soon as it passes the first stand-pipe opens the valve controlling the nozzle, when a stream of water under pressure is forced against the pallets under the carriages, accelerating the speed of the latter. As soon as each carriage passes, the valve controlling the nozzle is shut, and remains closed until the succeeding carriage opens it. The plans of M. Girard have been worked out in their present form by M. Barré, who claims many advantages for the system. The length of line laid down on the Esplanade des Invalides is about 200 yards, and the speeds attained are very considerable. The system possesses many points of great interest.—*Engineering.*

Measuring High Temperatures.—The last report of the Secretary of the Observatory of Yale University to the Managers contains the following:

"Although every certificate issued from this Observatory, for other than clinical thermometers, contains a statement of the only conditions under which the correction therein given can be truthfully applied, we are continually called upon to explain, especially in the case of high temperature thermometers, that when only the bulb is immersed in a liquid of high temperature the indicated temperature is too low by an amount depending upon the number of degrees of the mercury in the cooler stem and the difference between the temperatures of the bulb and stem. We have been called upon to show frequently that this error, which is independent of any correction due to the thermometer, may be as much as 8° or 9° in the case of high temperature oils, as their temperatures are generally measured. A simple remedy for this indefiniteness of measurement would seem to be a special form of thermometer in which nearly all the mercury should be immersed. As a result of considerable correspondence with parties interested in the accuracy of measurements of this sort, it was suggested that this Observatory should be represented at a convention held last January, but as it did not appear that the expense to the Observatory would be covered by the compensation likely to be received from this class of work, and the funds were wanting to enable us otherwise to render this public service, no encouragement was given to tender the proposed official invitation."

The Russian Navy.—At the present day the Russian Navy possesses several modern-typed war ships, which for thoroughness of construction and display of inventive genius certainly do great credit to that nation. Like the majority of other nations, the innovations which have made their appearance in the Russian Navy have been of comparatively recent date.

In 1864 the armor-clad ship *Petropaulovsk* was launched and in 1865 the *Netron-Menia*, another iron-clad vessel, was finished. These vessels are now classed in an obsolete type, being stricken off the list of efficient sea-going fighting craft. At the present time the old *Petropaulovsk* is serving out the remainder of her days as a receiving and training ship, being cut down to a harbor hulk. Just what has become of the *Netron-Menia* available history does not tell, but it is probable that she has been condemned long ago. In the early part of the decade commencing with 1870 the appearance of a class of vessels known as *Popoffkas*, or circular monitors, marked another offshoot in the Russian naval designs. These *Popoffkas* were designed especially for harbor protection.

It was not until the beginning of this decade that the really effective vessels of the Russian Navy began to make their appearance. The laying down of the keels of such vessels as the *Vladimir, Monomoski, and Dimitri Donskoi*, saw the work of construction commenced on a class of vessels of most formidable types. From this time on, the additions to the Russian Navy have been in cruisers and battle ships fully compatible with the times, and in most respects war vessels carrying armaments of a most formidable nature.

The Russian Navy is divided into two great divisions, known respectively as the "Baltic fleet" and the "Black Sea fleet." Each of these fleets is again divided into squadrons, of which there are three in the Baltic and two in or near the Black Sea. These two divisions constitute the naval defence at home in time of peace. In addition to the Baltic and Black Sea fleets are the various squadrons which are at all times on foreign stations. In the event of war they would be recalled to Russian waters, and either made a part of the naval defence or broken up.

The Baltic fleet comprises the greater number of armor-clad vessels, though several of the armored war ships in the Black Sea division are far the superiors of the great mass of vessels composing the divisions of the Baltic. There are no less than 31 complete armor-clad ships in the Baltic fleet, including 13 low freeboard or coast-defence ships, one unarmored frigate, five steam corvettes, and 11 first-class torpedo boats. Besides the foregoing there are four unarmored cruisers, one torpedo cruiser, three seagoing steamers, 15 gunboats, and 50 various craft, which include transports, training ships, and receiving vessels.

The Black Sea fleet includes the *Catherine II.*, the *Tchesma*, and the *Sinope*. In addition there are two *Popoffkas*, one cruiser, six gunboats, 10 armed steamers, one torpedo cruiser, 11 torpedo boats, and some 15 other craft of various types.

The most powerful vessels of the Russian Navy are the *Catherine II., Tchesma, and Sinope.* They were launched in 1886—the first two on the Black Sea. They are sister ships. Their dimensions are as follows: Length between perpendiculars, 320 ft.; greatest beam 69 ft.; mean draft, 26 ft. Prior to the advent of these three ships the most powerful vessel of Russia was the *Peter the Great.* This latter vessel was built at St. Petersburg and was the pride of all the Russias. She was built somewhat after the design of the British iron-clad *Dreadnaught*, though of larger dimensions. Her present engines are of English make, the original type, which was put in her at St. Petersburg, proving unsatisfactory. The four 12-in. guns of the *Peter the Great* are carried in two turrets.

Next in point of strength come the sister ships *Nicholas I.* and *Alexander II.* These vessels are 326 ft. long and have each a beam of 67 ft. The protecting armor belt of the *Nicholas I.* is 8 ft. wide, and varies from 14 to 4 in. in thickness, backed up throughout by 12 in. of solid oak. The speed of these vessels is about 17 knots per hour.

Next in order come the five belted cruisers mentioned on the list. The *Duke of Edinburgh* and the *General-Admiral* have each a length of 270 ft. between perpendiculars and a beam of 48 ft. They are built of iron and have an armor of 6-in. plates backed with a wood sheathing, which is between the armor and hull. The 6-in. armor, however, is placed only over the vital parts. The battery decks of these latter vessels are unprotected. There is a practically all-around fire to each of the guns.

The *Vladimir, Monomoski, and Dimitri-Donskoi* are the last additions to the Russian Navy of the armor-belted frigate type. They, too, are sister ships, being 295 ft. in length on the water line, with a beam at extreme parts of 52 ft. Their water draft aft is 25 ft., and their best recorded mean speed 15 knots per hour.

The Russians place considerable dependence in the four iron-clad turret ships named after admirals. They are sea-going cruisers, and resemble the *Prince Albert* type of vessels in the British Navy. Their turrets are of 4 6-in. armor plates.

Irrigation in India.—The report of the irrigation branch of the Indian Public Works Department on the irrigation system of the Punjab shows that excellent progress was made during the past year, and that good results were obtained.

This important system has now a total mileage of 3,730 miles of canal and 4,961 miles of distributaries, and during the year under review irrigated an area of 2,250,081 square acres. The system comprises the Swat River Canal, 22 miles; the Western Jumna Canal, 366 miles; the Bari-Doab Canal, 354 miles; the Sirhind Canal, 542 miles, of which 319 run through British territory and 223 miles through Native States; the Lower Sohag & Para Canal, 94 miles; the Sidhnai Canal, 37 miles; the Chenab Canal, of which only 62 miles out of the total length of 115 miles have been completed; the Upper Sutlej Canal, 220 miles; the Lower Sutlej & Chenab Canal, 92 miles; and the Muzuffargarh Canal, 723 miles.

The total area irrigated is now more than one-third larger than it was five years ago. The principal crops grown on the irrigated lands are wheat, cotton, rice, sugar-cane and corn, and have increased very largely during the past year. The

total expenditure of the system for the year was about $735,000, and the returns to the Government amounted to about 4 per cent. on capital expenditure, after deducting all the cost of maintenance.

Helicoidal-wire System.—An interesting application of the method known as the Helicoidal-wire system has recently been made by a Belgian company, at the old Roman marble quarries in Tunis.

The installation of the Société Anonyme Internationale du Fil-Helicoidal in the grounds of the Brussels Exhibition of 1888 exemplified the principal applications of this new method of working quarries. The endless wire cord is sent by the driving-pulley to a tension truck at the end of the yard, and, guided by pulleys with universal joints, is diverted at given points for sawing a mass of concrete and a block of marble, while there are also the following applications: A frame, in which the usual blades are replaced by cords for sawing slabs; a finishing apparatus; and a drill, driven by teledynamic rope, for sinking the shafts by which the cord-carriers are introduced, the whole being driven by a 14 H.-P. engine.

In most quarries, especially those of marble, it is less important to extract the greatest quantity of stone, than to obtain blocks of the form and size desired with as little waste as possible; and this is accomplished in a high degree by the helicoidal cord; while, manual labor being superseded by a regular mechanical operation, there is no need for skilled workmen, but only a few boys to tend the apparatus. A still further saving of labor is effected by the mass being subdivided into blocks of the desired size on the spot where it is quarried.

The rapidity of the operation naturally depends on the hardness of the stone; but it may be put roughly at 10 times as great as that by old methods, while concrete, and such rocks as cannot otherwise be worked, yield to the helicoidal cords. At the Exhibition, the same cord which sawed a block of marble also cut simultaneously a mass of concrete composed of quartz and flint pebbles.

Quarries in France, Algeria, Tunis, Italy, Spain, Germany, Russia, and Finland have been provided with the new apparatus, while it is exclusively used in the marble quarry of Traigneaux, near Philippeville, Belgium. Here the trench 60 centimeters, or nearly 2 ft. wide, which was formerly, as it is still generally in other quarries, made by hand, is superseded by vertical cuts with the helicoidal cord on all faces not detached, and a horizontal cut underneath the mass to be extracted. If the mass be not detached on any side it is necessary to run two cuts 2 ft. apart along one of the faces.

In order to permit the cord to descend, it is also necessary to sink shafts at all the angles of the mass where not detached, in order to receive the pulley-carriers; and this work is now performed mechanically by the drill invented by Mr. Thonar, at the same time preserving the cores for use as columns. It is usual to make three contiguous shafts, and break down the intervening angles; but the number and size of the shafts may be made subservient to the diameter of columns most in demand. The drill, driven by teledynamic cable, requires from 3 to 3½ H.-P., and descends at the rate of about 10 centimeters (4 in.) per hour in Belgian marble.

The endless helicoidal cord, composed of three steel wires varies from 100 to 300 meters in length, receives its longitudinal motion from a fixed engine, the requisite tension being preserved by a weighted truck on an incline. The downward feed is given by screws in the pulley carriers, turned either automatically or by hand; and the helical twist of the cord causes the rotary motion, which is demonstrated by the even wear of the wires. The cord serves as a vehicle for conveying the sand and water, the former of which is the real agent in cutting the stone.

The diameter of cord found most suitable for quarrying is 5½ to 6 millimeters, or less than a quarter of an inch, running at a speed of 4 meters a second, while smaller diameters and quicker speeds are adopted for subdividing the masses. A cut of 10 to 12 centimeters, or more than 4 in. per hour, is obtained for lengths of 3 or 4 meters in Belgian marble. In Quenast porphyry, which it had not before been found possible to saw, a cut of 3 or 4 centimeters, or from 1 to 1½ in. per hour, is obtained.

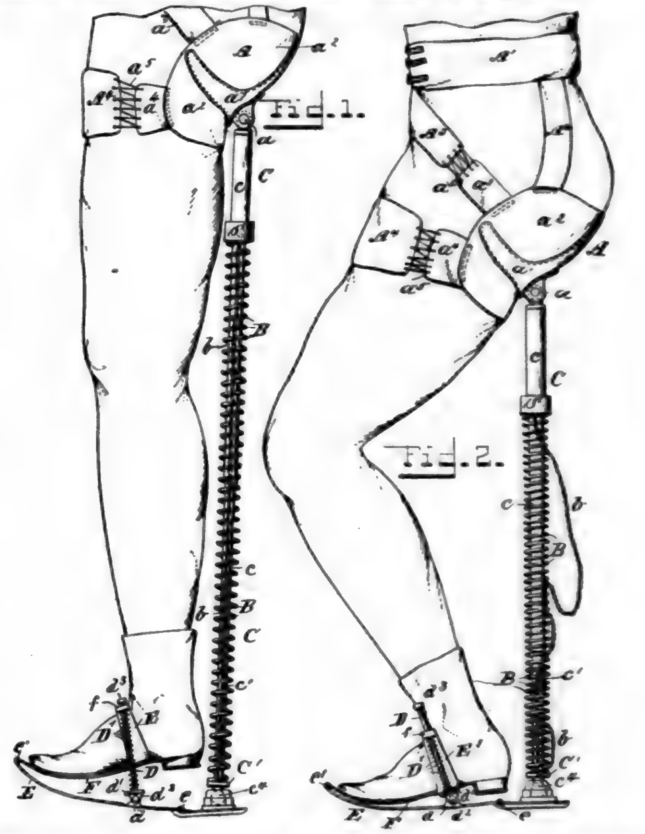
For quarrying, 2 H.-P. is found sufficient. If the cord should break, it is readily spliced; and a cord of average (150 meters) length will produce from 40 to 50 square meters of sawn surface, before wearing out, when it may be used for fencing. The sawn surface, plane if not smooth, is readily finished by the application of an amalgam of emery with lead, tin, and antimony, used in a machine like that for polishing glass.

New Use for Cork.—There is no subject which has received more attention from car-builders than that of buffer-springs for railroad cars. Stiff springs on passenger cars cause unpleasant shocks to travelers, and on freight cars damage to their contents.

M. Germond Delavigne proposes for this purpose the use of cork. He starts with the fact that a block of this substance 15 mm. (0.591 in.) in thickness can be compressed to 3 mm. (0.118 in.), or one-fifth of its original thickness, and that, when the pressure is removed, it regains its original size in a few minutes.

Buffer and traction springs have been made which are composed of 12 rings of cork 175 mm. (6.890 in.) in diameter and 15 mm. (0.591 in.) in thickness; these springs, used on the small cars of the Lens Coal Company, have given very good results. On the Northern Railroad experiments have been made with a series of 12 rings exposed to a pressure of 1,100 kilogs. per square centimeter (376 lbs. per square inch); after being submitted to this pressure they regained their original thickness in 10 minutes only.—*Le Genie Civil.*

Another New Rapid Transit Project.—In the April JOURNAL we described to our readers a plan devised by an American inventor for making them independent of railroads and other transportation companies, and furnishing them with an apparatus by which they could become their own rapid transit lines, and take the shortest cut through the air in any direction which they pleased. Not every one, however, may be willing to trust him or herself to the tender mercies of winds and cyclones, and it is, perhaps, to meet their objections that another inventor comes, who seeks to provide us with independent rapid transit upon the surface of the earth. His invention is shown in the accompanying illustrations, and while we have not space to enter into all of the somewhat complicated details, the picture will enable our readers to grasp readily the main idea, which is that of storing up, by a system of powerful springs, the muscular power exerted in bending the leg, and giving it out again when the leg is straightened. The inventor estimates that this spring arrangement will so support the body, help the muscles, and prevent waste of power, that the speed and endurance of a man in walking will be far more than doubled; that unheard-of feats in pedestrianism and in running and jumping may be executed, and that our natural locomotive powers will be so increased that we can afford to snap our fingers at rapid transit monopolies.

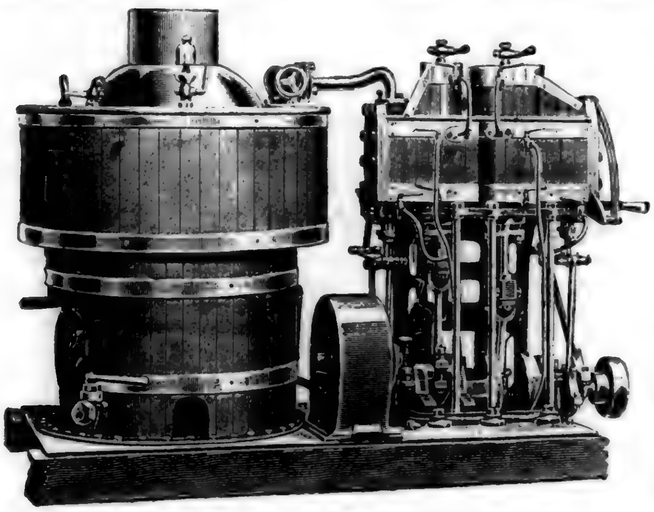


The inventor of this system is Nicholas Yagn, of St. Petersburg, Russia, and it is covered by United States Patent No. 406,328, issued under date of July 2 last.

It might possibly be objected to, by fastidious persons, that Mr. Yagn's arrangement would interfere slightly with the style of clothing at present worn by the adult male person; but that is a little detail to which we would soon become accustomed, and which will soon be arranged by general public opinion or consent, as soon as the advantages of his scheme become gen-

erally understood. For ladies, of course, no change of dress will be required.

An English Launch Engine.—The accompanying illustration shows a quadruple-expansion engine intended for a steam launch 50 ft. long and 7-ft. beam, which is exhibited at the Paris Exposition by Simpson, Strickland & Company, of Dartmouth, England. The boiler is intended to carry a working pressure of 175 lbs. The engine, which can exert about 40 H.P., has cylinders 3½ in., 5¼ in., 8 in., and 12 in. diameter, with 6¾-in. stroke, and is arranged on the tandem type. As will be seen from our illustration, the engine cylinders, which are lagged with teak, are supported on wrought-iron front columns, and a casting at the back on which the guides are formed. The engine is fitted with coupling and link-motion, all working parts being of steel. The feed and air pumps are driven direct from the crosshead



of the engine, without the intervention of levers or weight-shafts, and are attached immediately at the back of the web framing. These pumps are constructed entirely of gun metal, and are especially designed to work at as high a speed as 400 to 500 revolutions per minute. The bottom valve of the feed-pump is formed with a long spindle, made a working fit in a hole bored in the pump-plunger. The spindle, becoming coated with grease from the condensed water, causes sufficient friction to lift the valve at the commencement of the upstroke of the plunger, and keeps it open during the stroke, thus leaving a free passage for the water. At the commencement of the downstroke the friction causes the valve to close immediately, and it is in consequence of this arrangement that the pump can work at so high a speed. The bottom valve of the air-pump is made in the piston, which is allowed a small amount of vertical motion on the piston rod, and is so arranged that, on the downstroke, the friction of the packing against the bore of the pump raises it, leaving a free passage through the valve, and on the upstroke presses it down, so closing the passage, and compelling the contents of the pump barrel to pass through the top valve. Our illustration does not show the condenser, which is fitted on the starboard side of the engine, but distinct from it. The tubes are of solid drawn copper, and gun metal connections are fitted for passing through the shell of the vessel. The hot-well is of brass, connected to the feed and air pumps by copper pipes.

A quadruple-expansion engine capable of exerting 17 H.P. to 18 H.P. is also shown at the Exhibition. The cylinders are respectively 1¾ in., 2⅝ in., 4 in., and 6 in. diameter by 3½ in. stroke; and the engine is in every respect of similar construction to the larger one. A three-bladed propeller is attached on a length of shafting coupled to the engine shaft, to render the exhibit more complete. The propeller is 1 ft. 8 in. diameter and 4 ft. 8 in. pitch. The boiler is one of Kingdon's vertical natural draft type, constructed of Siemens-Martin steel for a working pressure of 175 lbs. per square inch. The grate surface is 1.76 ft., and the total heating surface, 27 ft.; the tubes, which are of brass, being placed vertically. Owing to the large size of the grate, steam is raised rapidly, and this feature also renders the boiler very efficient when using wood as fuel. The dome and funnel are also of brass, and the greater part of the boiler is lagged with teak. A gun metal hand feed-pump is fitted at the starboard side of the boiler, and a steam blast is also provided for getting up steam quickly. Where weight is limited, and a smaller boiler must be used, a small fan blast is fitted.—*Industries.*

Mississippi Levee Work.—The Mississippi Levee Commissioners give notice that they will receive, at their office in Greenville, Washington County, September 10, bids for the following levee work: Clove Hill, new levee, estimated at 136,000 cu. yds.; Eldorado to Tennessee, 43,000 cu. yds.; Tennessee to Purnell, about one-third new, estimated 67,000 cu. yds. Plans, profiles, and specifications can be seen and other information obtained of William Starling, Chief Engineer of the Commission.

Irrigation in Arizona.—The first attempt at irrigation on a large scale has been begun in Arizona. This Territory has always been regarded popularly as too dry for successful agriculture, but the fact is that the average rainfall in the central part of the Territory is quite as heavy, or even heavier, than in Southern California. The trouble is that the rain nearly all falls in the winter, when it cannot be used for cultivation, and that in the summer there is very little rain, and often none at all. When it does rain the water falls in such quantities that most of it runs off at once and does not benefit the soil. The effort in question has been made by the construction of a large dam at Walnut Grove, 30 miles southeast of Prescott, on the Hassayampa River. At this point there is a wide valley shut in on all sides by high mountains, the only outlet a narrow cañon, through which the water runs. Place a dam across the opening of the cañon where it leaves the valley, and the valley at once becomes a lake-basin. In fact, the geological formation shows that this valley once was an inland lake, the surrounding mountains intact, and the cañon but gradually worn away by the outflowing water. Block up the mouth of the cañon by an artificial dam, and the ancient lake is replaced. This is exactly what has been done in building the storage reservoirs at Walnut Grove.

The dam is of masonry and 110 ft. high, and the water-shed, which serves the river, is about 300 square miles. When the dam was built many, even those who were familiar with the country, doubted whether a sufficient supply could be secured to fill the basin, but in March last the combined effect of a heavy rain-storm and the melting of the snows on the mountains about the head-waters of the river gave a sufficient supply to bring the water up to within 5 ft. of the top of the dam, making a lake three quarters of a mile wide and 1½ miles long, and storing an immense quantity of water, which will be used this summer for irrigating the lands of the valley below.

A Steel Car Truck.—The accompanying engravings show a car truck, the chief feature of which is the cylindrical steel bolster, which is rolled out of a single piece of metal. On this are bolted cast-iron saddles of the form shown, to carry the center-pin, side-bearings, etc., each saddle being provided with

FIG 1.

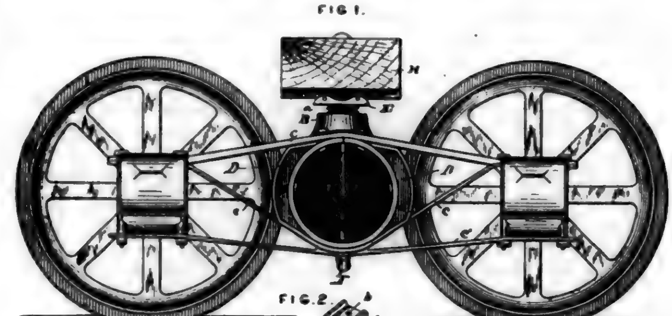
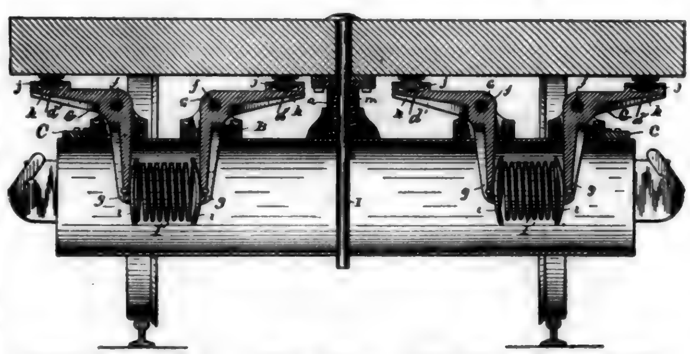


FIG. 2.

FIG. 3.



a socket in which is a coiled spring. The general construction is shown by the engravings, fig. 1 being a side elevation, fig. 2 a view of the brace, and fig. 3 a transverse section.

This truck is the invention of George E. Blaine, of Dayton, O., the patent being No. 404,676, dated June 4, 1889.

THE RAILROAD AND ENGINEERING JOURNAL.

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NEW YORK, OCTOBER, 1889.

THE Massachusetts Institute of Technology has established a new course in Sanitary Engineering. As must be necessarily the case of a course of this kind, it is essentially one in Civil Engineering, but differs from the regular course in that subject in some particulars. There is a reduction in the time devoted to railroads and bridges and also to the subjects of machinery, motive power, and geology, the time thus gained being devoted practically to courses in chemistry and biology, while in the fourth year a course of instruction is also given in heating and ventilation. The object is to give the student such special training as shall fit him properly to interpret the results of sanitary chemistry, and to co-operate with chemists and biologists in their professional work.

THE City of New York, which has adhered very closely to stone pavements in spite of, or perhaps because of, some unfortunate experiments with other kinds of pavement in past years, is about to undertake the repaving of a number of streets with asphalt. It would hardly be fair to call this an experiment, since this material has been used so much in European and some American cities; but it is something new in New York.

The street pavements of New York, although in many cases good when first put down, are very generally in poor condition, owing to neglect of maintenance and to the constant tearing up and cutting to which they are subjected. The granite block pavement, although it has the drawbacks of noise and dirt, stands the very heavy wear and tear of the business streets better than anything else; but for the streets devoted mainly to residences, where the traffic is comparatively light, it would seem as if the asphalt pavement would be superior in many respects.

A VERY practical effort to give instruction in trades and to replace the apprentice system, which is now practically obsolete, is found in the New York Trade Schools which have been in operation for eight years past, and which are gradually increasing their extent and usefulness. These are not schools in which so-called manual training is merely a part of the course, or in which a few hours of the week are given up to instruction in hand-work while the rest of the time is occupied by books; but are schools in which young men are taught their trade by actual practical work. The departments now included in the school are bricklaying and masonry, carpentry, plumbing, painting, blacksmiths' work, and tailoring. Both day and evening classes are provided so that those boys who find it necessary to work during the day, can obtain instruction after regular working hours, and the school is thus far one of the most hopeful efforts that we know of to reach a solution of the problem as to how our young men shall learn a trade.

THE Young Men's Institute in New York, which is a branch of the Young Men's Christian Association, is making another practical effort to furnish instruction by the educational departments at its rooms. A number of evening classes are provided, among which is one in the theory and practice of Steam Engineering, which is taught by a practical engineer, and is intended for engineers, firemen, and apprentices. This class opens at the building of the Institute, No. 222 Bowery, early in October, and continues throughout the winter and spring.

SHORT ocean trips continue to be the order, and the *City of Paris* on August 28 completed the best run from Queenstown to New York which has yet been made. The actual time from Queenstown to Sandy Hook was 5 days 19 hours and 18 minutes, and the total distance run was 2,788 miles. The best day's run made during the voyage was 509 miles, being an average of 21.2 miles per hour.

A PETITION carrying some 10,000 signatures has been sent to the Interstate Commerce Commission requesting that body to urge upon Congress the necessity of national legislation to bring about the adoption of automatic brakes and couplers for freight cars throughout the country. The signers, it is stated in the petition, are either now employed on railroads as brakemen, or have been so employed for a sufficient length of time to understand well the duties and dangers of the position. They present a statement of the number of trainmen who are yearly killed in coupling cars, and represent to the Commission that these figures are sufficient to authorize them to consider the question. The Commission has as yet taken no action in the case.

ON another page will be found an account of the experience of the Swiss railroads in the substitution of iron and steel for wooden ties. The results have been so satisfactory to the Swiss engineers that the question is no longer regarded as in an experimental stage, and metal ties have been adopted as the standard for all renewals on several of the Swiss lines.

In this connection it may be noted that the Permanent Commission of the International Railroad Congress in Europe has recommended that a uniform system of trials of metal ties be adopted by all the railroads connected with the Congress which are in position to undertake such a work. The plan recommended is to take trial sections of 500 or 1,000 meters; one to be laid with metal and the other with new wooden ties, under conditions as nearly alike as possible in relation to the sub-soil, dryness, drainage, etc., and to note carefully the cost of maintaining

each section through a series of several years. The results would no doubt give some valuable points of comparison, but the ultimate decision after all must depend upon the life of the iron or steel tie, and that can only be determined after a long series of years. From experience already obtained, it seems probable that the metal tie will outlast several wooden ones, although the long life of the wooden ties which had been subjected to some of the different processes for preserving timber on the Austrian State railroads still leaves room for some doubt on this point. At any rate, the results of the experiments recommended will be of much value and interest to engineers in this country as well as in Europe.

THE *Engineer* says that Mr. Webb, of the London & Northwestern Railway, has designed and constructed a locomotive with three cylinders, which are respectively 14 in., 14in. and 20 in. in diameter, with 24-in. stroke. This engine, our contemporary says, is not a compound engine, but a continuous-expansion engine. Steam from the boiler can be introduced directly into all three of the cylinders whenever a special tractive effort is needed, as in starting a heavy train or in ascending a steep grade. In ordinary work the steam can be and is expanded through all three of the cylinders. The engine is, of course, experimental, but it is stated that the results so far obtained are satisfactory. We do not understand, however, that the question is settled as yet, but that the experiments are to be continued.

THE new cruiser *Baltimore* made a remarkable record on her official trial trip, her speed averaging over 19 knots an hour on a four-hours' run, while at times she made over 20 knots. This places the new ship very high in the list of fast war-ships, and is a most creditable result for her builders and designers.

The *Philadelphia*, which was launched last month, will, it is hoped, do as well. She nearly resembles the *Baltimore* in design.

The recent trials of the *Yorktown* have also shown her to be a very serviceable vessel. These trials were made to determine her ability in manœuvring, and proved her to be a very quick and easily handled vessel.

On the whole, the new gunboats and cruisers promise to be ships of which no navy need be ashamed.

ANOTHER water transportation line, which has been in operation for a good many years, seems likely to be abandoned. The Pennsylvania Canal was so much damaged by the floods of last summer that it has been finally decided to abandon the work on a considerable section of it and to make no attempt to re-open it. Some 40 miles of the Canal will be retained in use, but for 90 miles, from Huntingdon to the Susquehanna River, it will probably be abandoned. This Canal, which was originally built by the State, has been for a number of years past owned by the Pennsylvania Railroad Company, and has been used chiefly for carrying coal, logs, and similar low-priced freight.

ATTENTION is called to the valuable diagram of Functions of Railroad Turnouts which accompanies this number of the JOURNAL as an inset, facing page 459. The directions and explanations accompanying the diagram will, it is believed, enable all engineers to apply it without difficulty, and the advantages of presenting these functions in a graphic form will be quickly appreciated.

FIRE-BRICK LINED FIRE-BOXES FOR LOCOMOTIVES.

THE most costly and the most troublesome and expensive part of a locomotive to make and to maintain is the fire-box. The inside plates are liable to crack, to corrode, and to burn out. The riveted seams, both inside and outside, often leak, and the outside plates are frequently corroded. Every locomotive superintendent and master mechanic is in constant fear of broken stay-bolts; crown-bars are heavy, expensive, and often a cause of trouble, and the braces and stays above the crown-bars are a source of constant anxiety. If we could dispense with all of these we would get rid of the most troublesome and costly parts of a locomotive.

A method of doing this has been proposed and experimented with, but for some reason—or, more probably, without reason—has not been favorably entertained by those who would be benefited most by such a change. As long ago as 1878 Mr. Stefan Verderber, Inspector-in-Chief of Hungarian State Railroads, took this subject up, and in a paper which he wrote on the subject said:

On most of the Hungarian Government railroads the feed-water is very bad, and forms large quantities of sediment; consequently the boilers of this company need more frequent and extensive repairs, particularly in their fire-boxes, than those of other companies having at their disposal a better kind of feed water. Under these circumstances I endeavored, as many other engineers have done before, to remove, or at least to lessen, this inconvenience caused by the failure of fire-boxes. Examining the investigations of others, I became convinced that only by abolishing the water-surrounded fire-boxes would there be a possibility of effecting a real remedy, and, in consequence, I tried to solve this problem, and contemplated the employment of a cylindrical tubular boiler combined with a fore-fire of fire-proof material for receiving the fire-grate.

The fact that the fire-box, with a moderate application of the blast pipe, produces nearly 50 per cent. of the whole steam produced by the boiler, has led to the false notion that the cylindrical part of the boiler is not capable of producing the necessary quantity of steam without the aid of the fire-box. My observations, however, led me to another conclusion. It first struck me why the heating surface of the tubular boiler performs so little work in comparison with the fire-box. The reason for the small capability of the boiler tubes in comparison with the fire-box are the following:

1. The burning gases pass only through a part of the tubes, consequently the other part is either quite or partly out of action.

2. The temperature of the burning gases diminishes during their progressive movement in the tubes, and therefore less heat will enter the boiler toward the smoke-box end.

3. Finally, and principally, the deficient heating capability of the boiler-tubes is accounted for by the fact that nearly 50 per cent. of the available heat is absorbed by the fire-box before the burning gases enter the boiler-tubes, in consequence of which they cannot possibly take up more heat.

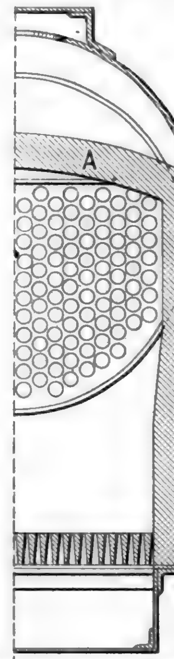
There is no reason at all why the tubes should—at equal temperature and density of the burning gases—evaporate less water per square foot of surface than the fire-box; I had, therefore, no doubt whatever that, if the burning gases at their original temperature could be led into the boiler-tubes, they would receive the whole available heat, and consequently the tubular boiler would do as much work without the fire-box as with it—that is to say, *the fire-box as a steam*-generating part of the boiler *is superfluous.*

This latter conclusion of Mr. Verderber has been received by locomotive men with the greatest incredulity. They say—what was admitted by him—that about half of the steam produced by a boiler is generated by the fire-box, and therefore if you take that away you dispense with the best part of your heating surface. In reply to this it may be said that the fire-box is the hottest part of the boiler, and therefore, quite naturally, the surfaces immediately around the fire absorb more heat than is communicated to the water through the heating surface in the

tubes. If one-half of the heat is communicated to the water around the fire-box, it is absurd to expect that there will then be as much left to be conducted by the tubes; but if the heat is not extracted from the fire in the fire-box it will enter the tubes, and, as Mr. Verderber remarked,

Transverse Section. *Longitudinal Section.*

Fig. 2.



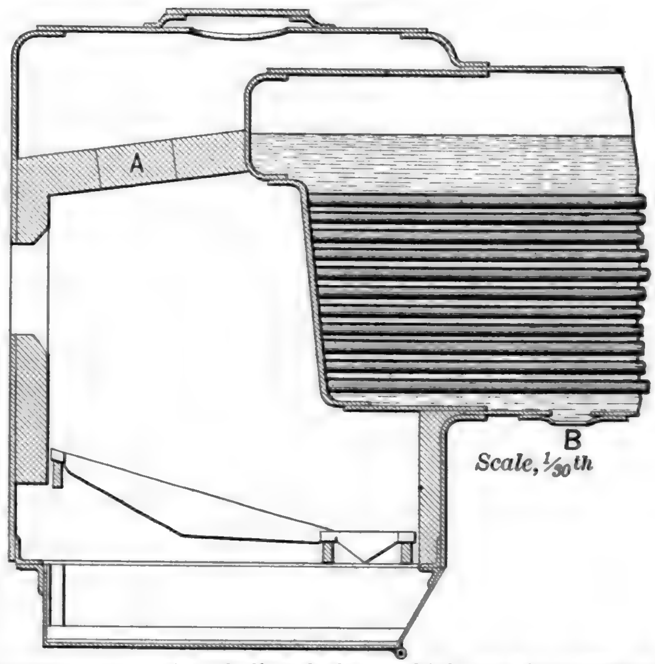


Fig. 1.

"there is no reason at all why the tubes should—at equal temperature and density of the burning gases—evaporate less water per square foot of surface than the fire-box."

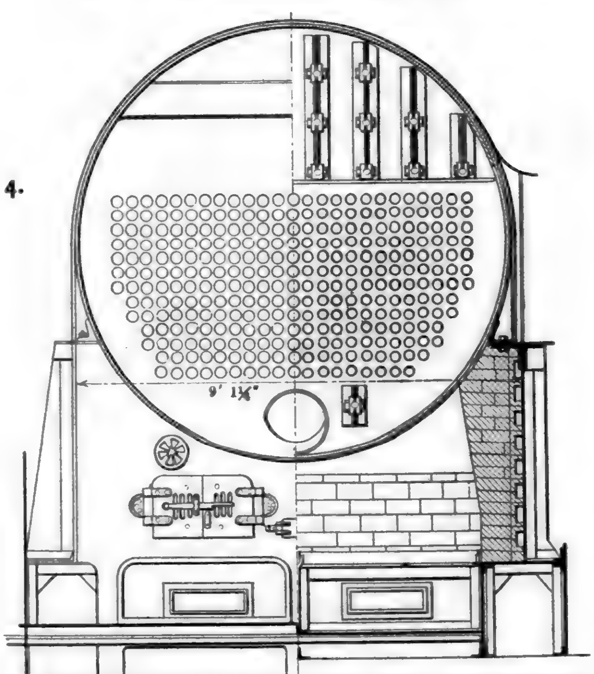
Having satisfied himself that the tubes would absorb the heat if it was not first abstracted in the fire-box, he took an ordinary locomotive, with water-spaces around the fire-box, and lined it with plates covered with fire-clay, leaving an air space of about 2½ in. from the fire-box plates, so that no heat could be conducted to them. It was found that with this arrangement a given weight of coal evaporated as much water as was evaporated before the change was made.

He then took an old boiler the fire-box of which required renewal and removed the inside plates, stay-bolts, etc., and put a new tube-plate in the back end, and lined the outside shell of the fire-box with plates covered with fire-clay, leaving a space between these plates and the outer shell as before, which was filled with mineral wool. This engine gave as good evaporative results after the change was made as it did before, but some trouble was experienced in keeping the tubes—which were brass—tight in the copper tube-sheet.

Being satisfied of the evaporative capabilities of such a boiler, Mr. Verderber then had a boiler, shown in figs. 1 and 2, constructed. In this arrangement he says, "The cylindrical part of the tubular boiler reaches into the fire-room, as shown in fig. 2; the tube-plate is composed of two parts, and has a play for expansion both in the vertical and horizontal direction." This fire-box at first was

End View. *Transverse Section.*

Fig. 4.



Longitudinal Section.

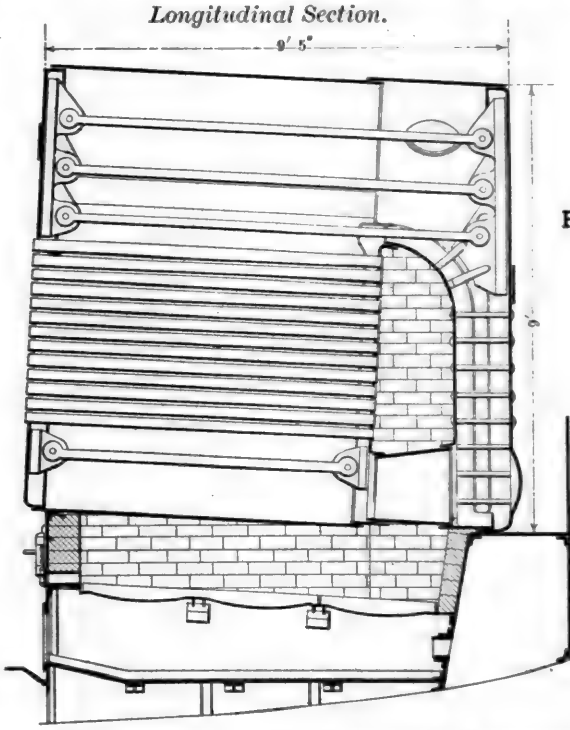


Fig. 3.

lined with the plate casing covered with fire-clay, but afterward a common fire-brick lining, with arched roof, was made, as shown in figs. 1 and 2, of which it was said, in the paper already quoted from, that, at the time of writing, it had worked about five months and had worn well. A careful set of experiments were made, which showed that this boiler gave practically as good evaporative results as boilers of the ordinary type.

There are now a number of steamboats and steamships which have fire-brick lined fire-boxes which have been in regular use for a number of years. The steamboat *Nashua*, of the Providence & Stonington line of steamers, running to New York, and the *Louisiana*, of the Old Dominion line, both have fire-boxes of this kind. The United States twin-screw steam cruiser *Chicago* also has boilers of this kind, represented by figs. 3 and 4.

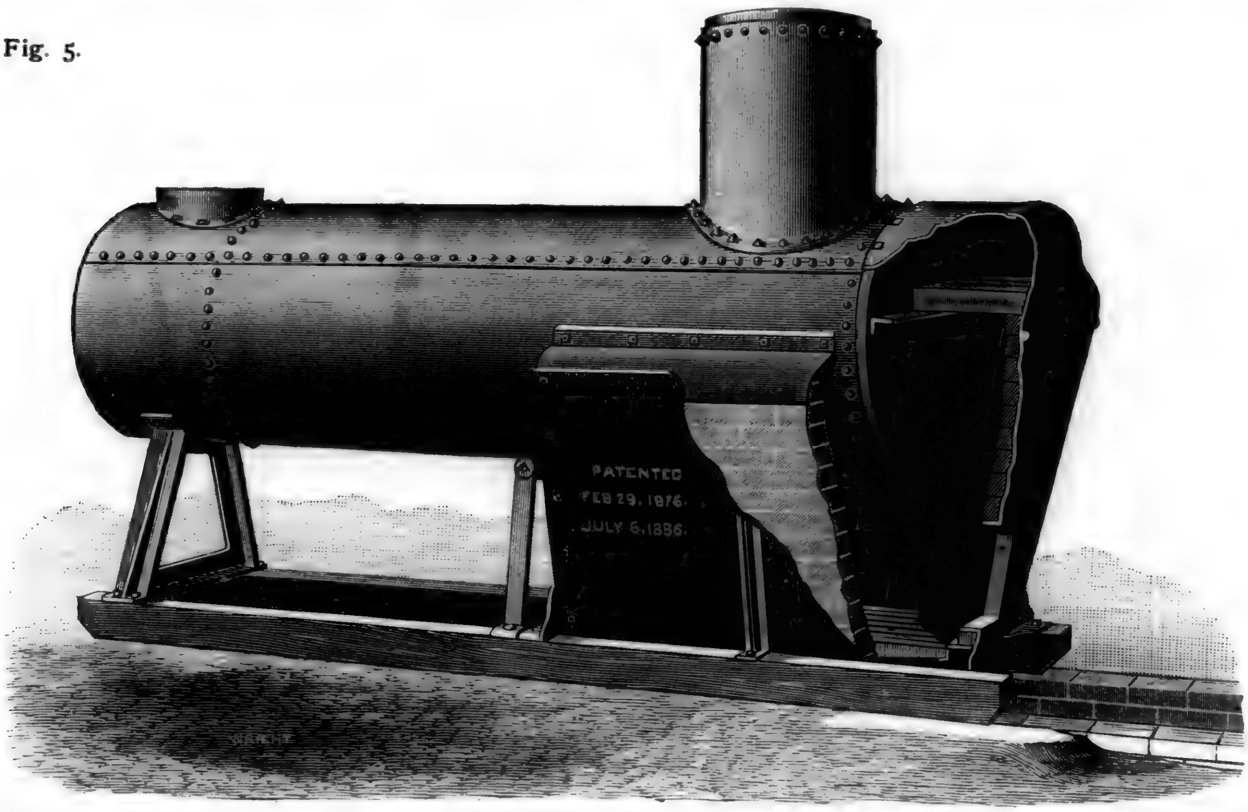
The purpose of this article is to show the entire practicability of using fire-brick lined fire-boxes on locomotives, and with that end in view to cite examples of such use under various circumstances and conditions. In doing this it seems hardly necessary to refer to the common form of brick fire-box used for stationary boilers. Thousands of these are in use in all parts of the world, and no one ever objects to their use, or even hints that they are not economical. Although the sides of such fire-boxes are of no service in *transmitting* heat to the water, it is equally true that very little or no heat is *conducted* through the walls of such furnaces and wasted. The same thing is true of the locomotive and marine fire-boxes which have been illustrated.

Fig. 5 represents a perspective view of a portable boiler which was patented by Walter J. F. Liddell, of Charlotte, N. C., and is manufactured by the Liddell Company of that place. In a trade circular issued by that Company, they say of ordinary portable boilers—and their observations are equally true of locomotive boilers—that:

The weakest and most exposed parts are the crown-sheet and furnace sides. They require to be heavily stayed to resist the pressure; and although most exposed to the fire, are yet the parts most liable to injury caused by low water or deposits of sediment. The first part exposed by low water is the crown-sheet, which is at all times subjected to the greatest heat, and yet has always the least water to protect it The sides of the furnace are ready receptacles for the deposit of mud and all impurities of the water, while the numerous stay-bolts required to strengthen them make them the most difficult parts of the boiler to keep clean. As a result *the furnace* of the portable boiler *is the great source of danger* and expense for repairs.

In the Liddell boiler these objections are removed, while at the same time the elements of portability and convenience are fully retained. In this boiler we have no flat crown-sheet, no furnace sides to fill with mud and burn out, no stay-bolts, and *but one seam* exposed to the fire. Instead of having *less* water over the crown sheet than in any other part of the boiler, we here have *more*, and the effect of low water is not to expose the crown-sheet, but the upper row of tubes, which may cause a leak but not an explosion, and will not endanger life. The fire-brick lining in the sides, when worn out, is easily replaced at a trifling expense, and the great cost of repairs, to which the ordinary portable boiler is subject, is saved.

Fig. 5.



The Superintendent of that Company says that boilers of this kind have very much greater steaming capacity than those of the same size with water-spaces, and that a greater economy of fuel results on account of the higher temperature which is maintained by the fire-brick.

Three different types of this boiler have been used, and there has been some difficulty in holding the brick in position, the greatest trouble has been from breaking the brick in the act of throwing wood into the fire-box. With the present form, having inclined sides and ends, the bricks and the castings last a reasonable time.

The boiler has been in use over ten years, the Liddell Company have built about 200 of them, and the Erie City Iron Works has made over 1,000 of them. The President of the latter Company says: "We have no trouble about getting our fire-brick to stand, as we have them made to pattern, and have very good means of holding them in place."

From the engravings it will be seen that the sides and ends of the fire-box are flaring or inclined. This method of construction has been adopted, the inventor says, "so that the fire-brick lining will be held against displacement by its own gravity, which tends to hold the bricks firmly in place against the flaring sides or wall of the fire-box." The flaring sides form the principal element of the patent.

In a paper on The Use of Petroleum Refuse as Fuel in Locomotive Engines, by Mr. Thomas Urquhart, Locomotive Superintendent of the Grazi-Tsaritsin Railroad of Russia, which was read before the Institution of Mechanical Engineers in London last January, he says that, having occasion to renew some worn-out copper fire-boxes, he adopted a modification of the Verderber furnace for two locomotives, goods and passenger, fired with petroleum refuse, which have now been running over two years. One of these boilers is represented by figs. 6 and 7. He says further, that "from his own observations with these two locomotives he would have no hesitation in using the plan for all his boilers, as there is much about it which, in his opinion, recommends it for firing with liquid fuel." The modification which he refers to consists in replacing the brick arch, which forms the roof, *A A*, figs. 1 and 2, of the Verderber furnace by a crown-sheet *A A*, figs. 6 and 7. The author says :

Transverse Section.

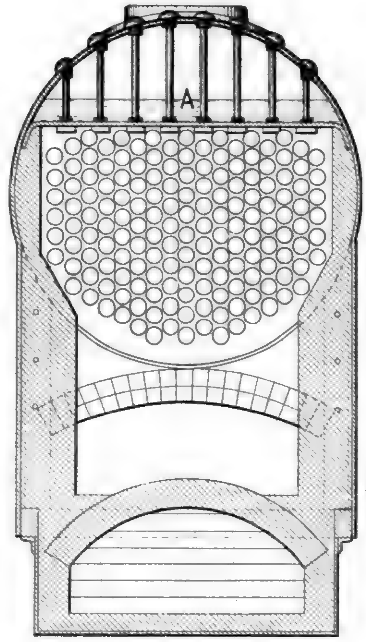


Fig. 7.

Longitudinal Section.

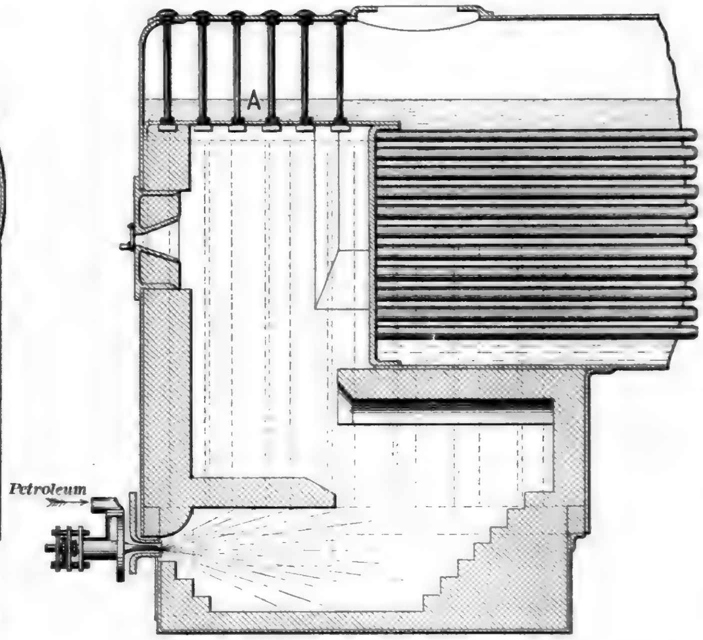


Fig. 6.

Sectional Plan.

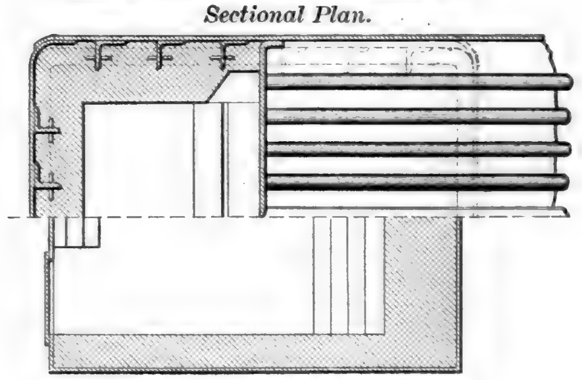


Fig. 8.

Scale, 1/30 th

This not only increases the water-space of the boiler and adds some very useful heating surface, but also appears to him to be indispensable for the two following reasons : First, there could be no guarantee that the brick roof of the Verderber furnace would not come down some time while running, and so bring the train to a premature stop on the line. Secondly, the crown-sheet, having water on the top of it, carries the water level back again to the original back plate of the fire-box, where all the water-gauge fittings are ordinarily mounted.

The consumption of fuel per train-mile with these fire-brick furnaces *is no more than with ordinary locomotive boilers having internal fire-boxes ;* and the author is indeed disposed to conclude that *there is a decided economy in their favor on this score.* In comparison with engines of the same class, but with ordinary fire-boxes, the mean of several trials made with the Verderber fire-boxes gave an economy of 8 per cent. in the passenger engine and of 4 per cent. in the goods engine, in saving of fuel per train-mile. But the greatest advantages of the fire-brick furnaces are the reduction in first cost and cost of maintenance, and *the shorter time the engines have to stand in the repairing shop,* inasmuch as the boiler repairs amount simply to changing the tubes and renewing the brick lining of the furnace. Even with coal, with which Mr. Verderber's experiments were made, the evaporation attained per pound of fuel was equal to that with the ordinary fire-box. The object of his plan, however, was not to effect economy in fuel, but rather to obviate the incessant damage to fire-boxes and the consequent stoppages, which were caused by rapid incrustation in the water-spaces surrounding the fire-box, from the very bad feed-water he had to contend with ; and this object he fully attained. The six-coupled goods locomotive, of which the furnace is shown in figs. 6, 7 and 8, was altered in August, 1885, and has been running ever since ; it had previously, when burning coal, 151 tubes of 2¼ in. diameter and a total heating surface of 1,248 square feet, including 82 square feet in the fire-box ; it has now 157 tubes of the same diameter, and 2 ft. 1½ in. longer, which with 13 square feet in the fire-box roof give a total heating surface of 1,410 square feet, or an increase of 162 square feet. As shown in fig. 8, the fire-brick lining is secured to the fire-box shell by means

of vertical angle-irons riveted to the shell plates and imbedded in the fire-brick.

In the discussion of his paper Mr. Urquhart said that "The cost of maintenance is less, and *the loss of time from the engine standing in the shops for repair is less than half what it would be in the case of an ordinary fire-box.*"

The fear has been expressed that the outside of a fire-box lined with fire-brick would be much hotter than one surrounded with water. With reference to this Mr. Verderber reported that he cased the fire-box with plate, and the space of about 2 in. was stuffed with slag-wool; consequently the temperature of the casing-plate is much lower than that of a common locomotive. He reported that "one may safely put his hand upon the casing-plate of the locomotive while working, which one could certainly not do on other locomotives." He said further: "My apprehension that the brick-work would suffer by the shaking of the engine has proved unfounded. . . . It will be of interest to technical men to know that the fire-brick lining of the combustion chamber stands perfectly well against the shaking of the locomotive as well as against the temperature of the fire-box."

With this evidence before us it seems quite safe to conclude:

1. That with a slight increase in the tube-heating surface a locomotive boiler, with a fire-brick lined fire-box and without water-spaces around the fire, will generate as much steam and do it as economically as an ordinary boiler will.

2. That such lining can be made to stand a reasonable length of service, and by lagging the outside it is not as hot as an ordinary boiler.

3. That the first cost and cost of maintenance of a fire-box of this kind, is materially less than that of one of the ordinary kind with water-spaces—that it is safer, will give better combustion, and that much less time is lost in making repairs than is required with the boilers now in use.

The advantages which would result from the use of such fire-boxes would be very great. It would reduce the locomotive boiler to a simple cylinder with tubes in it, and without any other bracing than that required for the upper part of the tube-plates. This would be the simplest and cheapest form of boiler to make. There would be no flanging of plates excepting for the edges of the tube-plates and the base of the dome. Stay-bolts would become a thing of the past, cracked and leaky fire-boxes would cease to worry boiler makers, expensive plates for them would no longer be needed, and crown-bars and their braces could be abolished.

We have been at some pains to collect all the testimony bearing on this subject, which is within reach, with the hope that some of the locomotive superintendents of the country would have sufficient faith in the new departure, and enough enterprise to give it a thorough test. The evidence which has been cited places it entirely beyond the stage of mere speculation and makes the success of the scheme reasonably certain. Who will be the first to try it in this country?

NEW PUBLICATIONS.

Naval Mobilization and Improvement in Material: being No. VIII of the General Information Series, Naval Intelligence. Bureau of Navigation, Navy Department: Lieutenant R. P. Rodgers, U. S. N., Chief Intelligence Officer. Washington; Government Printing Office.

We have before referred to this very excellent series issued by the Naval Intelligence Office, the object of which is to give a record of naval progress and of new inventions and improvements; primarily, of course, for the use of naval officers, but incidentally very interesting to engineers and other civilians.

The present issue includes papers on Naval Mobilization; the Naval Manœuvres of 1888; Armor; Gun Development and Naval Gunnery; Fish-torpedoes; Propulsion; Electricity for Naval Purposes; and the Resources of the United States for the Production of War Material.

There are also a number of shorter notes on ships, machinery, ordnance, armor, torpedoes, torpedo-boats, etc.

Probably the most interesting chapters are the one which reviews the great changes which have taken place in naval opinion concerning the distribution of armor on war-ships, and that which describes the great development which the resources of the United States for the production of war material have received during the last few years. This development has been really surprising, and goes far to prove how readily our manufacturers will respond when a demand arises.

How great a part electricity is coming to play on our war-ships, as well as everywhere else, is shown in the chapter on that subject, some extracts from which will be found on another page.

A Bibliography of Geodesy: by Professor J. Howard Gore, Ph.D.: being Appendix No. 16 to the Report of the United States Coast and Geodetic Survey for 1887. Washington; Government Printing Office.

As with the somewhat similar German book of Professor Boersch, which was noticed in the Journal for September, this work impresses one with an idea of the great volume of the literature which has been published on this subject. There are 195 large pages, with an average of about 25 titles to the page, so that the reader can easily figure out for himself how many books are included in the list.

The plan adopted in this index is to use only one alphabet, in which will be found subjects, abbreviations, and authors. The title of the book is given in the language in which it is published. Wherever possible—and especially in the case of rare books—the name of the owner, or of the library where it may be consulted, is given; this will be a great convenience to scholars who wish to find such books, or to procure material on the subject.

The amount of work involved in preparing a book of this kind can only be appreciated by those who have undertaken similar tasks. It is enormous, and so many thanks are due to those who have the courage and patience to begin and carry it through, that any criticism must seem ungracious. It does seem, however, as if the value of this index might have been increased by the use of more double titles or cross-indexing. The saving of labor to a searcher after knowledge would have been so great, that it would have fully warranted the required addition to the size of the book. This is a comparatively small matter, however;

setting it aside, Professor Gore deserves the thanks of all students of Geodesy for his work, which has a permanent value. The Coast Survey has done well to make it a part of the valuable series which it issues.

REPORT ON EUROPEAN DOCK-YARDS: BY NAVAL CONSTRUCTOR PHILIP HICHBORN, U. S. N. Washington; Government Printing Office.

This report is the result of a tour of observation made by Naval Constructor Hichborn, under orders from the Navy Department, some time ago. The chief object of the tour was to collect information with regard to improvements in naval architecture, particularly with relation to the construction of steel war vessels.

The report contains sections or chapters on National Dock-yards; Details, Fitting and Equipment of Naval Vessels; Torpedo Boats; Ship-yard Appliances and Tools; British Private Yards; Management of Work and Employés; Iron and Steel Works; and Docks. The descriptions of a number of the more important docks and ship-yards are illustrated by plans and other engravings; and there are also a number of engravings of ships and of tools and other appliances used in ship-building. The ship plans include the English *Rodney*, *Colossus*, and *Imperieuse;* the French *Sfax* and *Vauban;* the Spanish *Riachuelo*, and other famous battle-ships and cruisers.

Not the least interesting parts of the book are the chapters on those British Private Yards where so many war-ships have been built for all nations, and on the Management of Work and Employés, a subject of interest to builders everywhere.

Mr. Hichborn's report must be considered a valuable and interesting contribution to naval literature.

GENERAL SPECIFICATIONS FOR HIGHWAY BRIDGES OF IRON AND STEEL: SECOND EDITION, REVISED AND ENLARGED: BY J. A. L. WADDELL, CONSULTING BRIDGE ENGINEER. Kansas City, Mo.; published for the Author (price 25 cents).

Mr. Waddell's pamphlet on Highway Bridges attracted a great deal of attention when it first appeared, and was the means of starting a discussion which promises to do much toward raising the general standard of those structures. In the present edition there is much new matter, including the Preface; part of Chapter III, on Bridge Lettings; part of Chapter IV, on the Building of Bridges; and an additional Chapter (IX), giving discussions of the question by engineers. Some changes have been made in the proposed standard specifications, but none of importance.

That a reform in the methods of letting contracts for highway bridges is much needed there can be no doubt. Under the system now obtaining many bridge-builders of repute do not care to enter into such competitions, and a large share of the work has gone to men whose only aim is to make as much money as possible, without regard to the design and construction of the work, which may be as poor as can possibly pass muster. The great trouble has been that in most cases the final acceptance of the work rests with men who know nothing whatever of bridge-building. To correct this abuse and to establish some system of inspection, is Mr. Waddell's object, and his pamphlet has certainly served to draw attention to the subject. This is all that any author can hope to do, after all, and so in this case the book must be considered a successful one. It may also be said that it contains much matter of value to the engineer.

SOME DIFFICULTIES ENCOUNTERED IN THE OPERATION OF PUMPS, AS MET BY THE POSITIVE PISTON PUMP: BY JOSIAH DOW. Philadelphia; reprinted from the *Journal* of the Franklin Institute.

This is a reprint of a paper read before the Franklin Institute, the object of which is to show the difficulties inherent in the working of all reciprocating pumps. Mr. Dow makes a strong argument in favor of the advantages of continuous working in handling a column of water, as opposed to reciprocating action, and he sets forth the shocks to which the ordinary plunger or piston pump is exposed in a striking way.

Mr. Dow has had much experience in this line, and is the inventor of what he calls a "positive piston" pump, which has met with much success, and has worked very well on the lines which he has laid down in this paper.

REPORT OF THE PROCEEDINGS OF THE TWENTY-SECOND ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION, HELD AT NIAGARA FALLS, N. Y., JUNE 18, 19, AND 20, 1889: ANGUS SINCLAIR, SECRETARY. Chicago; printed for the Association.

An usual, the *Proceedings* of the Master Mechanics' Association appear with commendable promptitude, Secretary Sinclair's experience as an editor having taught him the advantages of placing the yearly report of the Convention before its public as soon as possible.

The volume contains about the usual amount of matter, and includes this year two or three reports of especial interest. Those on Thickness of Tires and Metal for Tires; on Driver Brakes, and on Driving and Engine Truck Boxes, called out most attention and discussion at the Convention, and will doubtless have the same effect outside of it.

MANUAL OF THE RAILROADS OF THE UNITED STATES: BY HENRY V. POOR. TWENTY-SECOND ANNUAL NUMBER, 1889. New York; H. V. & H. W. Poor (Price, $5).

In the September number of the JOURNAL, editorial mention was made of the valuable introduction to this publication, the advance sheets of which had been received. The book was not then delivered, but its receipt is now acknowledged.

No more difficult task is laid upon the reviewer than that which calls upon him to speak of a publication like *Poor's Manual.* To any one who knows the great difficulties which lie in the way of compiling statistics necessarily drawn from sources so various, and often so difficult to obtain, since they are furnished voluntarily, it need not be said that the completeness with which the *Manual* gives the figures published calls for the highest commendation.

Bearing this in mind, criticism seems ungracious when it is not laudatory; but, at the risk of seeming to be ungracious, such criticism must be made.

As the only authority on which those who desire the information given in the *Manual* can rely—at least for a very large part of it—the thanks of the public are due; but

while those who consult the *Manual* may fully appreciate its many good features, they have the right to ask the publishers not to rest upon their past achievements, but to remember that there is nothing so deceptive as figures based upon previous reports.

It is very easy to arrive at wrong conclusions from figures so obtained, and the fact that the *Manual* is so high an authority should warn the publishers to avoid falling into this error, which will eventually become fatal to their reputation if not corrected.

If space permitted, it would be pleasant to point out the features of the book which call for unqualified praise. The maps will be appreciated. The arrangement of the lists of officers of railroads is acceptable, and the information in the appendix is valuable, though the heading of "Foreign Railways" over a list which only includes the railroads of Central and South America is somewhat misleading until the sub-title is consulted.

BOOKS RECEIVED.

INTELLIGENCE REPORT OF THE PANAMA CANAL: BY LIEUTENANT CHARLES C. ROGERS, U.S.N., INTELLIGENCE OFFICER U. S. STEAMER "GALENA." Washington; Government Printing Office.

PROCEEDINGS OF THE SEVENTEENTH MEETING OF THE ASSOCIATION OF NORTH AMERICAN RAILROAD SUPERINTENDENTS, HELD AT NEW YORK, April 8, 1889: C. A. HAMMOND, SECRETARY. Boston; issued by the Association.

JOURNAL OF THE NEW ENGLAND WATER-WORKS ASSOCIATION, SEPTEMBER, 1889: F. H. PARKER, ALBERT S. GLOVER, EDITORS. West Newton, Mass.; published by the Association. This number of the *Journal* contains the proceedings of the Annual Convention at Fall River in June, with the papers then read and the discussions on them.

PUMPING MACHINERY, ANCIENT AND MODERN: BY J. F. HOLLOWAY. New York; issued by the Author. This is a lecture delivered before the Class of Mechanical Engineering of Sibley College, Cornell University, in April last.

UNIVERSITY OF VIRGINIA, SCIENTIFIC AND ENGINEERING DEPARTMENTS: ANNOUNCEMENTS, 1889–1890. Charlottesville, Va.; issued by the University. The Scientific Department of the University has received a great development in recent years, as is shown by the announcements contained in the present circular.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these papers includes four, all of value: Experiments on a Steam Engine, by Bryan Donkin, Jr.; Investigation of the Heat Expenditure in Steam Engines, by Professor Dwelshauvers-Dery; Armor for Ships, by Sir Nathaniel Barnaby; the Treatment of Steel by Hydraulic Pressure, by William Henry Greenwood. They also include an abstract of the discussion on Messrs. Greenwood's and Barnaby's papers.

REPORTS OF THE CONSULS OF THE UNITED STATES TO THE STATE DEPARTMENT: NOS. 106 AND 106½, JULY, 1889. Washington; Government Printing Office. This series, issued by the State Department, contains many valuable papers and reports, some of them worthy of especial attention.

GEARING: LIST OF GEARING PULLEYS, SHEAVES, ETC. Baltimore, Md.; the Robert Poole & Son Company, Engineers and Machinists. The size of this catalogue and the length of the lists of gear wheels of all descriptions give some idea of the great number of patterns owned and the extent of the business done by a long-established concern like the publishers of this catalogue.

A COMPILATION OF RESOLUTIONS, STATISTICS AND USEFUL INFORMATION PERTINENT TO THE MEXICAN SILVER LEAD ORE QUESTION. El Paso, Tex.; published by the Board of Trade, the Common Council, and the Southwestern Mining Association.

MACHINE TOOLS: ILLUSTRATED CATALOGUE OF LATHES, PLANERS, DRILLING MACHINES, SHAPERS, GEAR-CUTTERS, ETC. New Haven, Conn.; the New Haven Manufacturing Company.

PORTABLE ROPE HOISTING MACHINES: CATALOGUE AND DESCRIPTION. Philadelphia; the Energy Manufacturing Company.

MACHINERY FOR WIRE-WORKERS AND HARDWARE MANUFACTURERS: CATALOGUE AND DESCRIPTION. New Haven, Conn.; John Adt & Son.

UPRIGHT POWER HAMMER FOR DROP-FORGINGS, ETC.: CATALOGUE AND DESCRIPTION. New Haven, Conn.; the Belden Machine Company.

ILLUSTRATED CATALOGUE OF WOOD-WORKING MACHINERY. Norwich, Conn., and New York; issued by C. B. Rogers & Company. It is very fully illustrated, and shows a large assortment of wood-working tools manufactured by the firm, including every kind of tool needed in a car shop, or any factory where wood is used.

DUPLEX PUMPS FOR FEEDING STEAM BOILERS. Philadelphia; issued by the Barr Pumping Engine Company.

CAROLINA OIL & CREOSOTE COMPANY, CARBONIZED AND CREOSOTED TIMBER AND CROSS-TIES; DESCRIPTION OF FACTORY AND PROCESSES. Wilmington, N. C.; issued by the Company.

TIME-CHECKING MACHINES MANUFACTURED AND PATENTED BY LLEWELLIN'S MACHINE COMPANY, BRISTOL, ENGLAND: CATALOGUE AND DESCRIPTION. New York; issued by E. P. Spaulding & Company, Agents, 17 William Street.

ABOUT BOOKS AND PERIODICALS.

THE JOURNAL of the Military Service Institution for September contains articles on the Defenses of Puget Sound, by General John Gibbon; Hasty Intrenchments for Infantry, by Lieutenant W. A. Shunk; Desertion in the Army, by Lieutenant W. D. McAnaney; Artillery Organization, by Lieutenant E. M. Weaver; the West Point Cadet Uniform, by Assistant Surgeon James E. Pilcher. There are also the usual translations, etc., including a continuation of Prince Hohenlohe's Letters on Infantry and Artillery, and much miscellaneous matter of interest, besides a summary of the discussions of the Institute.

In HARPER'S WEEKLY for September 14 there is an interesting article on the Electric Motor Applied to Street Cars, by Henry Loomis Nelson. It is illustrated, and is intended to show what has been done in this direction and what has been proposed. The storage-battery and overhead-conductor systems are both described and illustrated.

The electrical articles in SCRIBNER'S MAGAZINE for October are on Electricity in Naval Warfare, by Lieutenant W. S. Hughes, U.S.N., and Electricity in Land Warfare, by Lieutenant John Millis, U.S.A. Professor N. G. Shaler has an article on the Improvement of Common Roads, a subject which is just now attracting much attention.

The NORTHWESTERN MECHANIC, a monthly recently started in Minneapolis, Minn., has passed under the editorial management of Mr. James F. Hobart, who is well known as a writer for the technical press. It is a bright and independent paper, and seems determined to earn a place, and to deserve the prosperity which we hope it will secure.

HYDROGRAPHY AND HYDROGRAPHIC SURVEYS.

By Lieutenant Henry H. Barroll, U.S.N.

(*Continued from page* 413.)

VIII.—THE HYDROGRAPHIC OFFICE AND THE NAVIGATOR.

When Lieutenant Maury first began the collection of meteorological data, he enlisted the assistance of the Merchant Marine of our own as well as foreign nations. Log-books were furnished them, in which were entered the records of the observations made during the entire cruise, and these books, upon the vessel's return, were sent to Washington, where the records were collated, and those observations which corresponded in locality were gathered together. In this way much more accuracy was to be obtained than by trusting to any single account.

The system of arranging the data collected is briefly as follows: The whole water surface of the globe is divided into squares of five degrees of longitude by five degrees of latitude, and each of these squares so formed has a distinctive number assigned to it. That portion of a ship's time that is consumed in passing through any particular square, and the observation for wind, temperature, etc., taken during this time, are, at the Hydrographic Office, separated from the rest of the record, and entered in a book bearing the number of this square. For example, suppose a ship to be on her way from Liverpool to Cape Henry, a certain portion of her time will be passed in crossing from latitude 40° to latitude 35°, and from longitude 60° to longitude 65°. The square bounded by these latitudes and longitudes is square No. 782; therefore, in book No. 782 will be recorded all of the data taken from the time the vessel entered these limits till the time of her departing from them; at which time the succeeding data will be entered in the book of the succeeding square, and so forth.

By the arrangement of this data the Hydrographic Office comes in possession of observations extending over a number of days, months, or even years spent in this same square, although so remote from land as to preclude the idea of sending a vessel there to take continuous observations.

The periods of time that the various vessels have passed in each square are added together, and the mean of all observations is taken, and that is regarded as the state of the weather for that space of time at the center of this square. For each month the mean of all observations taken during months of that name represents the state of weather to be expected for that month in the future.

These observations consist in noting the temperature of the air and the water, the height of the barometer, the force and direction of the winds, the amount of time, and locality in which fog or rain is encountered, number and position of icebergs seen, etc., while the difference each day between the distance that the ship has traveled through the water and her absolute position, as determined by astronomical observations, shows the amount and direction of current that has been experienced from day to day.

The first chart having been made of any given section of the ocean, the work of the Hydrographic Office may be said to be only begun; constant care and vigilance must be exercised in securing and reporting changes and new dangers. Notice of these are received from all over the world and in all sorts of shapes. They include not only new discoveries made, new shoals formed, channels obstructed, and similar matters, but also changes made in positions of lights, buoys and other warnings, which are communicated promptly to each other by the hydrographic offices of the different civilized nations.

Among the early navigators it was a very common practice to place upon their charts warning marks which became denominated "Vigias," from the Spanish word, meaning "lookout."

A captain would see at some distance what appeared to be a shoal or breakers. It might be impracticable for him to make closer examination, yet he would report it as a *possible* danger.

This practice is kept up at the present day, but greater care is now taken to determine the absolute existence of the danger.

The Hydrographic Office issues a notice warning mariners of the *supposed* danger, and as soon as possible a vessel is sent to examine that locality.

Vigias are marked on the chart-plate thus, "* Vigia (?)." When it is found that they do not exist, a notice is issued to that effect, and the word and characters are removed from the chart-plate.

Should their existence be proved, the word "Vigia" and doubtful sign are removed from the chart-plate, and the rock or shoal is given a name.

Our naval vessels are constantly making surveys, which have expunged from the chart, or have verified, many of these supposed dangers.

There are over 8,000 light-houses in the world and hundreds of thousands of buoys. About 800, or one-tenth of all the light-houses, are on the coasts of the United States.

The use of a light-house is not always clearly understood by landsmen. It may be said to be simply an anchored star showing the mariner by *its* position what is *his* position; from his chart he ascertains where the light-house is placed, and shapes his course accordingly, and it is therefore of the greatest importance to him that he should have prompt and correct notice of any changes made in the position and character of lights.

IX.—BRANCH HYDROGRAPHIC OFFICES.

To facilitate the receipt and distribution of such information, it was deemed expedient in 1884 to establish branch hydrographic offices in the six largest seaboard cities—Boston, New York, Philadelphia, Baltimore, New Orleans and San Francisco; later, also, at Norfolk, Va., and Portland, Oregon.

All information that any of these branch offices can obtain is forwarded direct to Washington.

The offices are also depots where the latest information of any maritime nature whatsoever will be found.

For example, the change of character of a light, or the discovery of a shoal, on the French or Spanish coast, is reported by the Hydrographic Office of that nation to the Office at Washington. There the news is translated into English, published, and numbers of the notices issued to the several branch offices, from which, as centers, they are distributed along our entire coast.

A very important question to navigators is the determination of latitude and longitude. The latitude is easily ascertained, but the determination of longitude is a somewhat more intricate problem, and to this work the Hydrographic Office has given much attention. The general question of change of time with longitude is doubtless familiar to most intelligent people, and its discussion is hardly necessary here. At sea it is customary for navigators to change the time at noon, setting it back when going west and forward in going east, according as the longitude may have changed, the amount of change being determined by astronomical observation. The work of ascertaining these points has been very much simplified in later years by the increased excellence of the chronometer, and by the possibility of comparing the ship's chronometer with standards established on shore. These standards may be found at all the branch hydrographic offices in this country, and the use of the telegraph has enabled us to compare these standards at a number of different points, thus insuring their correctness.

In a word, these branch hydrographic offices are depots of marine information, where the captain of a vessel can find a full library of sailing directions and lists of all the charts published by the Government. Here he can obtain the latest information with regard to any port in the world, and can learn what charts or books may be necessary for him on the voyage he may be about to undertake.

The latest location of derelict vessels and floating icebergs are plotted upon the monthly pilot chart, on which also is recorded the limit at which ice may be expected in each month, and also the probable limits of foggy weather. This information is obtained from the reports received at the offices, and the probable limits of ice and

fog are recorded from experience. The limits in which the trade-winds are expected will also be found laid down on the chart. The experience referred to is the result of observations extending over many years, and each additional year adds to the accuracy with which probabilities may be laid down.

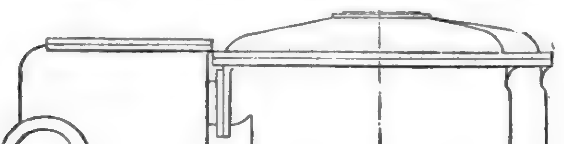
It may here be noted that the courses of some abandoned or derelict vessels have been plotted upon the charts from reports received, and some of these wandering wrecks have pursued erratic and remarkable paths. The schooner *Twenty-one Friends*, abandoned near Hatteras some six years ago, wandered about the North Atlantic for over two years, and was finally towed into a Spanish port on the Bay of Biscay.

In addition to furnishing information, the branch hydrographic offices also correct charts and adjust barometers, distribute lists of lights and beacons, and will obtain information which may be needed from the central Office at Washington.

As an instance of the amount of work one of these offices may be called upon to do, it may be stated that in the first four months of its establishment, the Norfolk office distributed 43 light-lists; 95 hurricane pamphlets; 2 reports on the use of oil to calm the waves; 70 day-marks; 576 pilot-charts; 832 supplements to pilot-charts; 1,864 notices to mariners; 14 coast survey notices; 11 monthly weather reviews and 9 cyclone charts. The Officer in charge reported 11 storms; 1 fog; 1 water spout; 26 wrecks; 10 buoys adrift and 8 light-ships adrift. He visited 132 different vessels; adjusted 3 barometers; corrected 120 charts and 3 day-marks, and gave information of different kinds to 3,834 persons.

A COMPOUND MARINE ENGINE.

THE accompanying illustrations, taken from *Industries*, show a very remarkable set of compound engines lately completed for the Italian armor-clad ship, *Ruggiero di Laura*, at the shops of Maudslay, Sons & Field, of London, England, from the designs of Mr. Charles Sell, the



head of the Engineering Department of that firm. The engines are of the three-cylinder compound type, having a high-pressure cylinder 61 in. in diameter and two low-pressure cylinders 80 in. in diameter each; the stroke of all being 39 in. As shown in the large engraving, the high-pressure cylinder is set in the middle, with a low-pressure cylinder on each side. The engines are upright and act directly upon the shaft, the cranks being set 120° apart. The framework is entirely of steel and is thoroughly braced together, so as to secure the greatest possible rigidity, combined with lightness, and in this way it has been found possible to obtain great power with a very moderate weight. With the exception of the cylinders, steel and gun-metal are the only materials entering into the construction of the engines.

The valve-gear of these engines is of the Joy pattern, fitted on the sling-link plan, in which the sliding block is replaced by an oscillating link. This type of gear is preferred for large engines in preference to the ordinary Joy gear, which is considered more suitable for small engines. An outline of the valve-gear is shown in the smaller cut, and its operation will be readily understood from this diagram. The sling-link *D* is suspended from a horseshoe lever *E*, which is supported in the fixed trunnion bearings *F*. The position of the horseshoe lever controls the cut-off and the direction of the motion, and this position is controlled by the main reversing lever *G*, a screw adjustment *B* being provided for the high-pressure cylinder, in order to give facilities for adjusting the proportion of cut-off in this and the two low-pressure cylinders. Motion is transmitted to the valve-lever *I* and the connecting-rod *C* by means of a connecting-lever *H K* suspended from the rod *A*. This arrangement of levers constitutes a kind of parallel motion and insures a correct cut-off both in forward and backward gear.

The contract for these engines provided that they should develop at least 10,000 H. P., but on the official trial trips, in the Gulf of Spezia, they attained a maximum of 12,000 indicated H. P., and the average for the whole trial was 11,400 indicated H. P. The engines thus showed a result of 14 per cent. in excess of the contract requirements.

OIL AS A METALLURGICAL FUEL.

(Paper read by E. C. Felton, before the American Institute of Mining Engineers.)

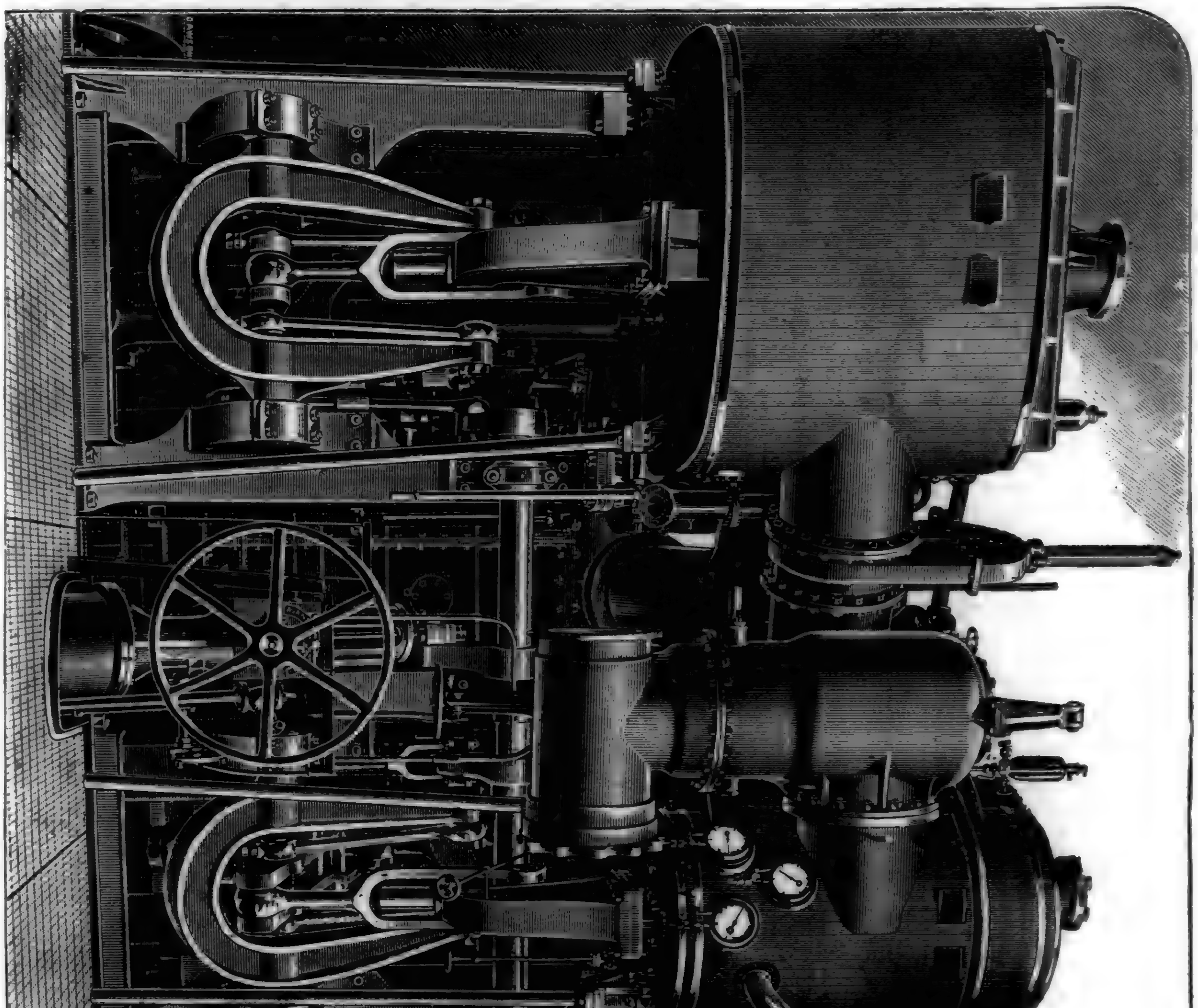
AT the Pennsylvania Steel Works, Steelton, Pa., a series of trials has been made with oil as fuel in steel-heating and open-hearth steel-furnaces with the following results:

First Trial.—Hot 14-in. ingots, six to a charge, were heated in two Siemens' heating furnaces in the blooming mill, the oil being put in first in March, 1888. The oil used had been partly refined, so that the paraffine and some of the naphtha were removed. During a run of six weeks the consumption of oil was about 6¼ gallons per ton of blooms, including the oil required to keep the furnace hot over Sunday.

Second Trial.—The same partly refined oil was employed for melting in a 30-ton open-hearth furnace, the charge being cold scrap and pig, with ore. Although the gas was carried from the producer to the furnace, a distance of about 300 ft., the oil-consumption, as the average of a month's run, was 48 gallons per ton of ingots, including the oil required to keep the furnace hot over Sunday.

Third Trial.—Oil was introduced on June 11, 1888, to heat six Siemens' heating-furnaces in the blooming mill, and has since then been constantly used. For a period of six months, including the fuel-consumption on Sundays, and including the heating of some cold ingots, the consumption of Lima oil was 6 gallons per ton of blooms. The quantity of oil required naturally varies with the product of the mill. Under the most favorable circumstances—charging hot ingots and with all the stock supplied which the furnaces can handle—4½ to 5 gallons of oil are required per ton of blooms. Cold ingots must remain in the furnace for about three hours.

Fourth Trial.—Lima oil was used for heating a 30 ton open-hearth furnace, the producer being located near it. As the average of a six weeks' run, 54 gallons of oil were required per ton of ingots, including the fuel consumption over Sundays and for starting the furnace. The record of the first week was 46.7 gallons of Lima oil per ton of in-



COMPOUND ENGINES OF ITALIAN CRUISER "RUGGIERO DI LAURA."

gots. It was found that the loss is somewhat greater than with coal-gas, and that some trouble was experienced from the fact that fine particles of oxidized iron clogged the checkers.

Fifth Trial.—Work in a 5-ton open-hearth furnace, in use since December, developed a fuel consumption ranging between 50 and 55 gallons of oil per ton of ingots.

Sixth Trial.—Oil was applied to the raising of steam under two 100 H.-P. return-flue tubular boilers, the temperature of the feed-water being about 160° Fahrenheit. The results showed an average evaporation of about 12 lbs. of water per pound of oil, the best 12 hours' work being 16 lbs. of water evaporated per pound of oil. At the relative prices of oil and pea-coal, the former is not as economical under boilers as the latter.

In all of the trials the oil was vaporized in the Archer producer, an apparatus for mixing oil and superheated steam, and heating the mixture to a high temperature. From 0.5 to 0.75 lb. of pea-coal is used, per gallon of oil, in the producer itself.

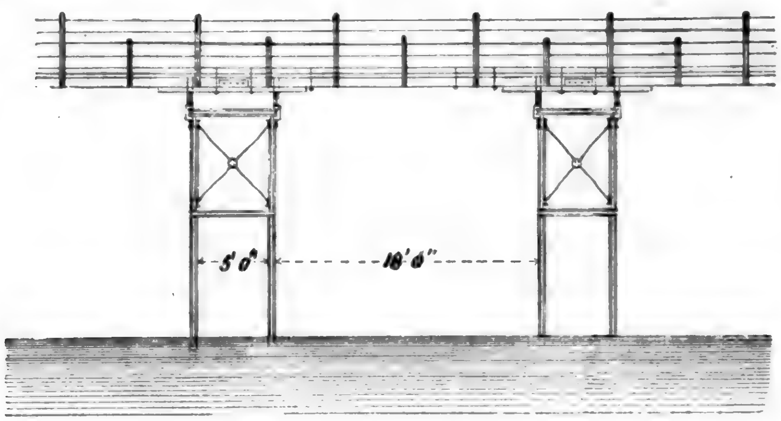


Fig. 2.

ELEVATION.

CROSS SECTION.

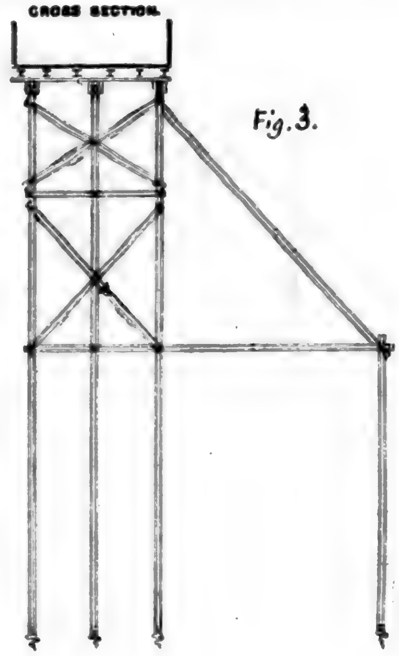


Fig. 3.

A BRIDGE OF OLD RAILS.

A BRIDGE OF OLD RAILS.

(A. T. Lahiri in the *Indian Engineer.*)

OLD railroad iron has hitherto been utilized only in the construction of culverts and bridges of a very limited span. A new departure has lately taken place in the use of the material, for, on June 22, a bridge of 236 ft. clear waterway, wholly composed of rails, was opened for traffic in the Rangpur District.

A description of this work may be interesting to your readers; for it appears to combine cheapness and strength. The height is 25 ft. above the bed-level, and 9 ft. above the highest flood-level of the River Ghagat which it spans. The piers, eight in number, are of two rows of rail piles placed 5 ft. apart; each row, consisting of three single piles 4 ft. apart, is strongly scarfed with steel fish-plates and scarfing plates 3 in. × 5 in. × ⅞ in. The piles are driven to a depth of 14 to 15 ft. by 2 ft. diameter cast-iron screws. In driving, a hard layer of earth 2 to 3 ft. deep was met with at a depth of 4 ft., and below this there is ordinary sand of the Terai down to a depth of 45 ft., in which the piles are imbedded. They are braced strongly on all sides, both diagonally and horizontally, with old rails, thus forming a strong pier 8 ft. × 5 ft., and are topped with a bracket piece of channel iron fixed by strong bolts, on which rest rail waling pieces.

The superstructure is very simple; it consists of six rail corbels 2 ft. apart each, carrying a rail girder, over which roadway planking of 6 in. × 3 in. teak scantlings are laid and held down at two sides by clip bolts passing through two teak wheel-guards of 4 in. × 4 in. section. The hand railings consist of T-iron uprights 5 ft. and 3 ft. 6 in. high, alternately, fixed by bolts to side girders and wheel-guards. At each side there are four parallel pieces: the lower two consisting of 1¼ in. diameter gas-tubes, and the upper two, passing through the high standards only, are of ordinary telegraph wire. The superstructure is braced to its supports by ⅞ in. × ⅞ in. strong stirrup pieces. The abutments consist of puddled earth sloped two to one, well rammed and neatly turfed. The piles at the abutments are underground, and the two piers next the abutments of a moderate height: both consist of a single row of three piles. To prevent oscillation from lateral wind and current-pressure, the high piers have been strutted on the up-stream side by rails running from the top of each row of the pier-piles to fender posts, driven for the purpose 16 ft. from the bridge. These will act both in tension and compression. The iron-work has been fixed throughout with strong bolts, as riveting in this backward district would have been costly and unsatisfactory. The approaches to the bridge are 20 ft. wide, and have been constructed with a gradient of 1 in 100, which will not tax the tractive power of bullocks too heavily. The bridge is constructed with a headway of 9 ft. clear above the highest known flood, identical with that allowed on the railway line a few miles up-stream. The bridge consists of four spans of 17 ft. 6 in., and seven of 18 ft., while the piers provide for eight clear spans of 5 ft. each, so that the total opening is 236 ft. Its clear width is 10 ft., sufficient for a single cart to pass. A bridge calculated for a double line of carts would have been too costly for the limited funds at the disposal of the District Board, under the auspices of which it has been constructed.

This useful work occupied only 15 weeks in completion, including the high approach roads, and this in spite of some delay in procuring materials and tools from Calcutta. At the beginning of March last earth-work at the approaches was taken in hand. On March 16 the staging was taken in hand and the first pile was hoisted March 28. Up to April 15 the work progressed but slowly, and for three days was at a standstill, owing to the delay in getting materials and the greater difficulty in procuring skilled labor. However, by dint of constant exertions, the pile driving was resumed on April 15 and finished on May 10. The work of fitting and fixing the superstructure occupied from May 10 to June 15. There was no lack of unskilled

laborers, who were supplied by Rup Lal Mistry, a railroad contractor, whose resources are very large; but smiths and carpenters were imported from Rajshahye and Naddya, as none were locally available.

The actual cost is as yet uncertain, but there is no reason to doubt its exceeding the estimate of $6,250, including a new diversion road and high approaches. It does not exceed $26.50 per running foot, including cost of approaches, and, all things considered, must be considered extremely moderate.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page* 403.)

II.—PROJECTILES.

Up to the time of the advent of the armor-plate, projectiles of all kinds—solid and hollow—were made of cast-iron. Against a target of this kind common cast-iron

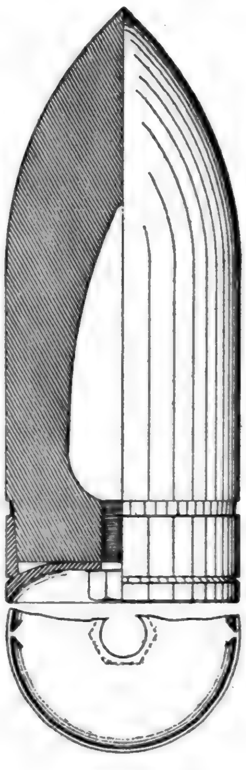


Fig. 12.

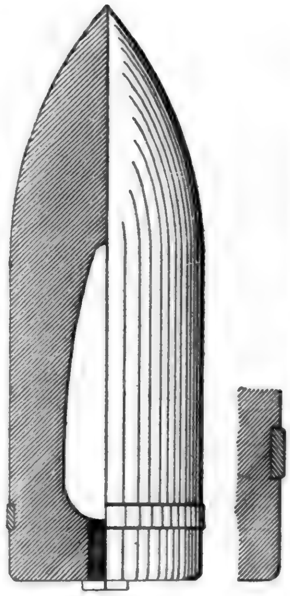


Fig. 13.

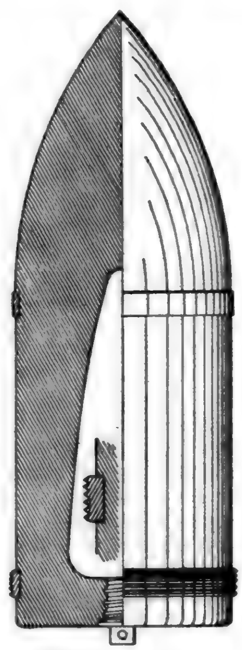


Fig. 14.

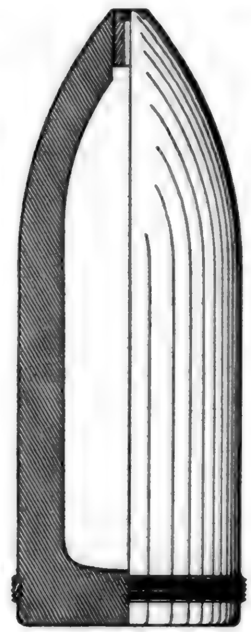


Fig. 15.

lacks tenacity, and a projectile of this metal will fly to pieces like glass. Wrought-iron, on the other hand, while possessing great tenacity, is wanting in hardness, and flattens out like lead upon impact with the hard face of an armor-plate.

The first advance in the direction of securing greater penetrating power for projectiles was in the manufacture of what were known as chill-shot. The metal, of carefully selected qualities of iron, was cast in metallic molds, and, of course, rapidly cooled. The product possessed great hardness and considerable tenacity. In Germany it was known as Grüson cast-iron. In England projectiles of this kind were known as Palliser shot and shell. They differed from both the Grüson and the French chilled projectiles in that only the head was cast in chill, the body having the ordinary sand mold.

When in the development of the armor-plate wrought-iron gave place to steel, and at the same time the powder-makers and the gun-makers in conjunction gave us well-nigh double the old velocities, it was found that even the best chilled cast-iron projectiles failed to do the work required of them, resort was had to steel.

All armor-piercing projectiles are now made of steel, and almost without exception are hollow. Battering shell and cored shot are almost identical in shape. Their general form is shown in figs. 12, 13, and 14. The advantage of a hollow over a solid projectile lies in the fact that in it the center of gravity is thrown well toward the point and greater steadiness of flight and less inclination to glance off should the plate be struck at an angle. If a bursting charge be used, we have the additional effect of the explosion to be added to the energy of impact.

The fabrication of these projectiles requires great care and skill. In France, where their manufacture began, they have reached a high degree of excellence. Other European powers have followed suit upon different lines, but all employing steel of the finest quality, cast or forged, and tempered with as much care as one would give to a fine piece of cutlery. In the United States little progress has as yet been made in procuring armor-piercing projectiles. The Secretary of the Navy, in his last report, laments that during the previous year but *one* serviceable shell had been furnished. In England, for some time, Armstrong's was the only firm which would undertake to furnish forged and tempered steel shell, but of late a number of Birmingham and Sheffield firms are engaged upon this kind of work.

The first cast-steel armor-piercing shell were cast solid, point down, with a sinking head. The mold for the point and body was metallic, while that of the sinking head was of sand. When cool the sinking head was cut off and the chamber bored out in a lathe. To temper, the projectile was heated in a reverberatory furnace to a cherry-red, the point receiving a higher temperature than the base, and then plunged into cold water and immediately afterward immersed in oil. Later fabrications are cast hollow.

Forged steel armor-piercing shell are cut from steel bars of proper size. They are hammered to the general form of the shell, and afterward turned and tempered. The details of the manner of tempering followed at the French works at St. Chamond are interesting. The shell are first brought to a cherry-red throughout, plunged in oil and kept immersed until cold; they are then again brought to a cherry red, hung with the head, as far as the front band, in cold water for ten minutes, and afterward immersed in oil until cold. After this treatment they cannot be touched with a file, and possess a tenacity that will take them through a steel target equal to their own diameter, or greater, and often without a scratch.

In the Low (English) projectile, the metal is forged and turned as indicated above, and after being brought to a red heat is placed point down in a metal mold and sub-

jected to a gradually increasing hydraulic pressure. Great hardness of point and tenacity are obtained.

The manufacture of these armor-piercing steel projectiles is hardly beyond the experimental stage, and yet to understand the wonderful results attained it is necessary to read of some of the competitive trials that have taken place since 1885.

In some trials had in Italy three years ago, to test the relative merits of Holtzer chrome steel and Krupp steel shell, three empty shell weighing about 80 lbs. each were fired at short range from a 5.9-in. Armstrong gun, with a 40-pound charge against an 18.9-in. solid steel Creusot plate, with a velocity of a trifle less than 1,900 feet-seconds. The report goes on to say that with the Holtzer chrome projectiles each of the three penetrated the plate a depth of but little less than 10 in., and the "shell *rebounded in each case entire, without any appreciable deformation.*" With the Krupp projectiles the penetration was nearly 9 in. for each, which "rebounded entire; slight setting up of body, but more marked than in the Holtzer shell."

We also read of an experiment made about the same time (1886) in Russia, to test the merits of Krupp and St. Chamond (French) steel projectiles, in which an 11-in. 554 lbs. St. Chamond, with an initial velocity of nearly 1,500 feet-seconds, penetrated 15¼ in. into a Cammell compound plate, rebounded 30 ft. and was found to be intact.

In December of the same year a St. Chamond 42-cm. steel battering shell was driven *through* a 19.7-in. Creusot steel plate, with a striking velocity of but a little over 1,400 feet-seconds, and was recovered entire and without cracks and but slightly set up.

In October, 1887, a trial of projectiles was had in England, in which a 12-in. Holtzer steel projectile, weighing 714 lbs., with a charge of 295 lbs. was fired against one of the best Brown & Co.'s steel-faced 16-in. compound plates. The striking energy was about 1,700 foot-tons. The shot perforated the plate, passed through 10 ft. of solid backing, and was stopped by a piece of old armor-plate in the rear, "and was so little deformed that apparently it could have been fired again."

In the English experiment a 6-in. shell perforated a 9-in. Brown compound plate; one of 8 in. passed through a 12-in. plate of the same manufacture.

At Gâvres, last autumn, a French steel shell was fired against a 15¾-in. Creusot plate (solid steel), which it pierced, and when picked up afterward in the sea, 1,500 meters beyond, had undergone no appreciable deformation.

During some experiments at Meppen, last year, with Krupp steel projectiles, two 21-cm. steel shot, with a striking energy of a little less than 8,000 foot-tons, were driven in succession through a 15½-in. Cammell compound plate, supported by substantial backing of oak and two skin plates, and when recovered were slightly upset, but otherwise were uninjured.

In connection with these reports it must not be forgotten that in these trials the conditions were always favorable for the gun, the ranges were very short, and, in the instances cited, the impact was normal to the surface of the plate—two conditions not likely to occur in an actual engagement. It must also be borne in mind that in these tests the projectile was not always successful. There were many times where the shot only half did its work. They are given to show what the high-power gun, provided with projectiles worthy of it, *can* do, when pitted against its old enemy, the armor-plate. That the gun, at the date of present writing, has the advantage, can hardly be questioned; that it will maintain the lead is by no means certain, though, it seems to us, extremely probable. It might be added that at various times during these trials chilled cast-iron projectiles, of the Palliser and other types were tried, and without exception broke up without inflicting any appreciable injury to the plate.

The first projectiles for rifled guns were about 1½ calibers in length. To-day 3½ calibers is the usual length. For armor-piercing various forms of head have been experimented with. Projectiles with flat heads and with concave heads, to insure their taking hold when striking at an angle, have been tried, but at present nearly all projectiles have the ogival head, struck with a radius equal to about 1½ diameters.

III.—ENDURANCE.

Every piece of ordnance has a certain length of life, varying with the different conditions of metal, method of construction, charge, projectile, and system of rifling, if rifled. This life is measured by the number of rounds it may be fired without danger of rupture. In the days of smooth-bore guns about 1,000 rounds was considered as the measure of their life. With the Parrott cast-iron, reinforced rifles used during the Rebellion, about 250 rounds was considered the limit of their safety. When fired beyond this number precautions were taken to assure the safety of the cannoneers in case of bursting. Some burst before this number had been fired, others exceeded it, and one is said to have reached its two-thousandth round before rupture. It was never possible to predict when these guns would succumb. In the experiments with converted guns a number of them were fired from 500 to 800 rounds and still remained serviceable. Of two 8-in. cast-iron rifles cast in 1865 one burst at the eightieth round, while its companion piece was fired more than 800 rounds without bursting. Cast-iron in this case, as in that of the Parrott rifles, was found to be unreliable.

The life of the built-up, high-power steel gun has not as yet been fixed. Our 8-in. Army rifle has been fired over 200 rounds without appreciable deterioration. Some of the Navy guns have considerably exceeded this number. One of the 119-ton Krupp guns has been fired 200 rounds and is still in good condition. It is, perhaps, safe to say that the limit of safety will fall somewhere between 300 and 500 rounds.

IV.—ACCURACY.

Perhaps in no one quality does the modern gun excite our admiration more than in that of accuracy. Many instances might be given of wonderfully accurate practice. A few examples will show, however, its capabilities in this direction. Our 8-in. Army rifle at 3,000 yards range, placed the centers of 10 shots within a circle 6¼ ft. in diameter. The 119-ton Krupp gun at 2,500 meters (2,734 yards), in nine successive shots, made a target in which the mean vertical deviation was but 1.1 meters, the horizontal deviation, 2 meters. In other words, a circle 12 ft. in diameter would have held the centers of all these nine ton-weight projectiles.

In the Meppen trials of 1879 a Krupp 71-ton gun put consecutively the centers of eight shots within a parallelogram 5 ft. 8 in. wide by 19 in. high, at 2,700 yards range. During the same trials a 4½-in. field gun, fired under a high angle and using a projectile of less than 30 lbs. weight, at a target 10,300 yards distant (about six miles), put 50 per cent., or five out of 10 shots, within a parallelogram 20 by 80 ft.—the size of the deck of a small steamer.

In April of the present year, at Shoeburyness, in England, the 4.72-in. Armstrong rapid-fire gun, at 1,300 yards, made five hits out of five shots on a six-foot square target, in 31 seconds.

What is expected, as regards accuracy, of guns in the future, is well shown in the stipulations of our Army Fortification Board previously referred to. At 1,500 yards both the 10-in and 12-in. guns are to put 25 per cent. of their shot in a rectangle 1 by 1.4 ft., and at 10,000 yards into a rectangle 9.2 by 48.5 ft.

V.—RANGE.

The extreme range of very few high-power guns has been determined by actual firing. The difficulty of getting a carriage that will withstand the enormous strain brought upon it by high-angle fire, limits the *practicable* to but little more than one half the *possible* range of most of these guns. The maximum possible range of the best of them is about 12 miles. On shipboard about seven miles may be considered the maximum practicable range. During the English Jubilee last year a round for range was fired at the Shoeburyness practice-ground from the 9.2-in. wire-wound gun. The measured range was 21,000 yards, a trifle less than 12 statute miles. Our 8-in. B. L. Army rifle, with a charge of less than 100 lbs. has given a range of over six miles.

The value of a piece of ordnance is determined by the amount of work it can accomplish, and is measured by the number of foot-tons of energy it is capable of imparting to its projectile. This energy may be expended either in overcoming atmospheric resistance—that is, in range, or, as in heavy guns, in beating down walls or penetrating armor plates. It will vary directly as MV^2. In comparing the capabilities of guns of different calibers this energy is usually expressed in terms of foot tons per inch of circumference of projectile. If a racking or smashing effect were desired then the totals would determine the best gun. If, however, range or penetration were to be the test, the energy per unit of surface would properly be the standard of comparison.

With high-power guns the measure of efficiency is usually stated in terms of the number of inches of wrought-iron plate its projectiles will perforate. In a rough way it may be stated that a pointed projectile will penetrate about its diameter in wrought-iron for every 1,000 ft. of velocity at moment of impact. For penetration in steel an allowance of from 25 to 30 per cent. must be made.

In the fabrication of heavy guns, both as regards ballistic qualities and actual size, Krupp leads in the race. His largest gun, which is the largest ever yet constructed, is a 119-ton piece, with a caliber of 15.75 in. and capable of throwing a 2,300 lb. projectile. Four of these guns were finished three years ago for the Italian Government; three have been delivered and one is still retained for experimental purposes.

HEAVY ORDNANCE OF DIFFERENT NATIONS.

Country.	Character of Gun.	Weight, tons.	Caliber, inches.	Powder, pounds.	Shot, pounds.	Muzzle velocity, feet-seconds.	Muzzle energy, foot-pounds.	Length of bore, caliber.	Penetration in wt.-iron at 1,000 yards.
Engla'd	Steel B. L. (wire)..	22	9.2	270	380	2520	18,728	..	23.2
"	Wt.-Iron & Steel—M. L.	100	17.75	575	2000	1735	46,300	20	28.5
"	Steel B. L.	105	17	772	2000	1814	45,675	27	29.7*
"	" "	111	16.25	1000	1800	2128	57,680	30	33
France	" " (34 cm.)	52	13.4	337	926	1968	24,870	28.5	24.8*
"	" " (42 ").	75	16.5	295	1720	1739	36,000	22	26*
G'many	Krupp Steel (B. L.)	71	15.75	485	1715	1700	34,500	20	23.8
"	" " "	119	15.75	846	2314	1899.5	58,122	31.8	35
Russia.	Steel, B. L..	80	16	....	....	...	....	..	..
U. S. ..	Cast-iron, B. L....	55	12	250	800	1700	16,187	28	19.5
" ..	" and Steel-converted	7.5	8	35	180	1385	2,480	14.7	7.42
" ..	Steel, B. L., Army	13⅛	8	113	300	1875	7,200	30	..
" †..	" " "	27	10	....	....	....	. ..	..	..
" ..	" " Navy	12	8	112	250	2008	7,285	30	18 2*
" ..	" " "	25	10	250	500	2002	13,870	31	21.5*
	Proposed Guns.								
Engla'd	Steel, B. L. (Woolwich)...........	156	19	....	...	....	...	..	..
G'many	Steel, B.L.(Krupp)	139	15.75	....	2300	....	..	..	..
"	" " "	150	17.5	....	3300	....	. ..	..	..
U. S. ..	" " (Army)	30	10	.. .	575	....	15,000	34	..
" ..	" " "	52	12	...	1000	...	26,000	34	..
" ..	" " (Navy)	44	12	425	850	2100	25,985	35	27.6*
" ..	" " "	75	14	675	1350	2100	41,270	..	32.2*
" ..	" " "	110	16	1000	2000	2100	61,114	32	36.8*
	Rapid-Fire Guns.								
Engla'd	Armstrong........	4200	4 72	12	45	2073	...	33	10*
"	"	..	6	42	110	...	. ..	..	15*
G'many	Krupp.............	2645	4.13	8.6	40	1729	....	35	..
"	"	5510	5.12	17.6	66	1640	....	35	..
France &U.S	Hotchkiss..... ...	3637	4	12.5	33	2034	....	42	10*
U. S. ..	Driggs-Schroeder..	..	4	....	....	.. .	....	...	..

* At muzzle. † Under construction.

England follows closely with her 111-ton Woolwich gun, which, though of considerably less weight than its German rival, uses a larger powder charge and very closely approaches it in the total energy stored up in its projectile. France has finished a number of 42-centimeter guns of 75 tons weight; they have, however, not yet been sufficiently tested to enable one to judge of their relative merits. In the United States a 10-in. 25-ton steel gun is the best we can show, and with the best of luck in our gun-making the last decade of the century will be well toward its close before we can hope to reach the present state of efficiency now attained in European ordnance.

In the table given herewith I have endeavored to show the present state of heavy ordnance possessed by the leading military powers of the world, and the best recorded performances of the guns described. Of modern high-power rifles England, France, Germany, and Russia may be said to be the only European nations having distinctive systems; to this list we may now add the United States. Italy, while ambitious to develop a system of ordnance of her own, is as yet dependent upon England and Germany. Spain, too, is said to be about to attempt heavy gun construction on her own account. The lesser powers of Europe, the South American Republics, Egypt, China, and Japan look to European gun-makers for their supply of heavy guns.

In the development of heavy ordnance it is to be observed that, while during the past 10 years guns have greatly increased in both weight and length of bore, the caliber has remained stationary or has somewhat decreased. The 71-ton Krupp had a 15.75-in. bore; the 119-ton gun is the same. The caliber of the original 100-ton English gun was 17.75 in., that of the 111-ton gun is 16.75 in. While Krupp is now building a 140-ton gun of some 40 calibers in length, the diameter of the bore is to remain the same as in the other guns in his system—40 centimeters. The English, however, in their proposed 156-ton gun seem to have fixed upon a 19-in. bore. There are not wanting military authorities to predict that the gun of the future will be, relatively speaking, of smaller caliber than those that are being turned out to-day. If we can increase the length of projectiles to 4½ or 5 calibers, and at the same time secure increased initial velocity, we can well afford to reduce somewhat the caliber of our guns, and still be able to penetrate any practicable thickness of armor that a ship can carry, while the gain in the matter of ease of manipulation and rapidity of fire will be a decided one.

THE GIRARD HYDRAULIC RAILROAD.

(From *Industries.*)

We give herewith some illustrations of this railroad, which has recently excited so much technical interest in Europe and America, and which threatens to revolutionize both the method and velocity of traveling, if only the initial expense of laying the line can be brought within moderate limits. A short line has been laid in Paris, and we have there examined it, and traveled over the line more than once; so that we can testify to the smoothness and ease of the motion. Sir Edward Watkin examined the railroad 10 days ago, and we understand that a line two miles long is to be laid in London, under his auspices. He seems to think it might be used for the Channel Tunnel, being both smokeless and noiseless. It might also, if it could be laid at a sufficiently low price, be useful for the underground railroads in London. We are favorably impressed by the experiments we have witnessed; our misgivings are as to the cost.

The railroad is the invention of the well-known hydraulic engineer, M. Girard, who, as early as 1852, endeavored to replace the ordinary steam traction on railroads by hydraulic propulsion, and in 1854 sought to diminish the resistance to the movement of the wagons by removing the wheels, and causing them to slide on broad rails. In order to test the invention, M. Girard demanded, and at the end of 1869 obtained, a concession for a short line from Paris to Argenteuil, starting in front of the Palais de l'Industrie, passing by Le Champ de Courses de Longchamps, and crossing the Seine at Suresnes. Unfortunately, the war of 1870–71 intervened, during which the works were destroyed, and M. Girard was killed. After

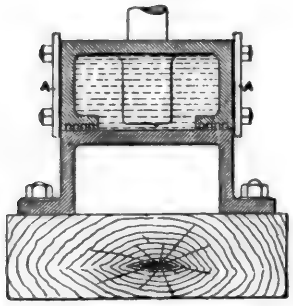


FIG 1.

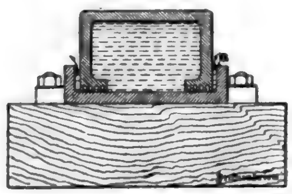


FIG 2.

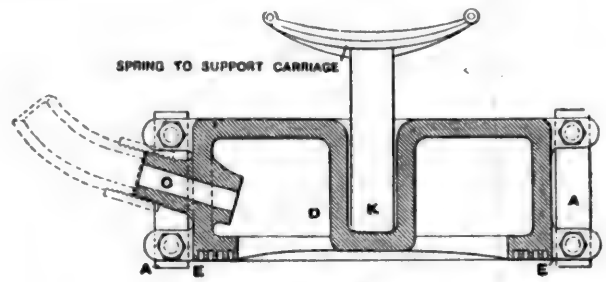


FIG. 3.

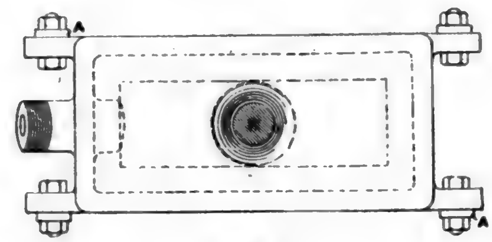


FIG. 4.

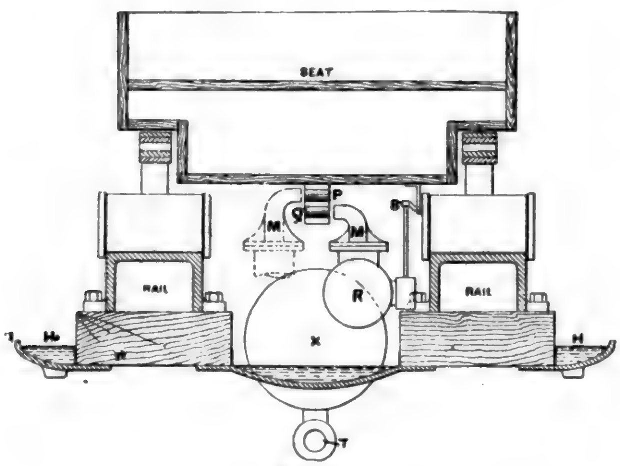


FIG. 6.

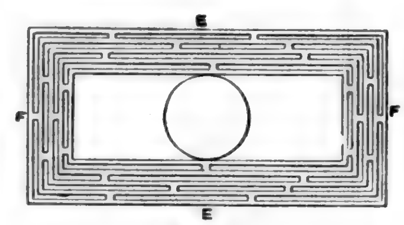


FIG. 5.

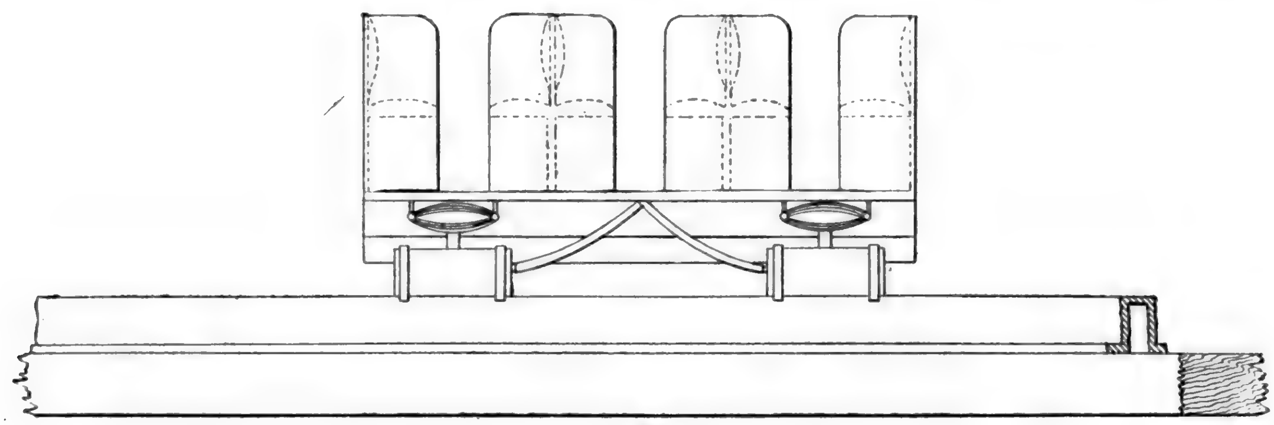


FIG. 7.

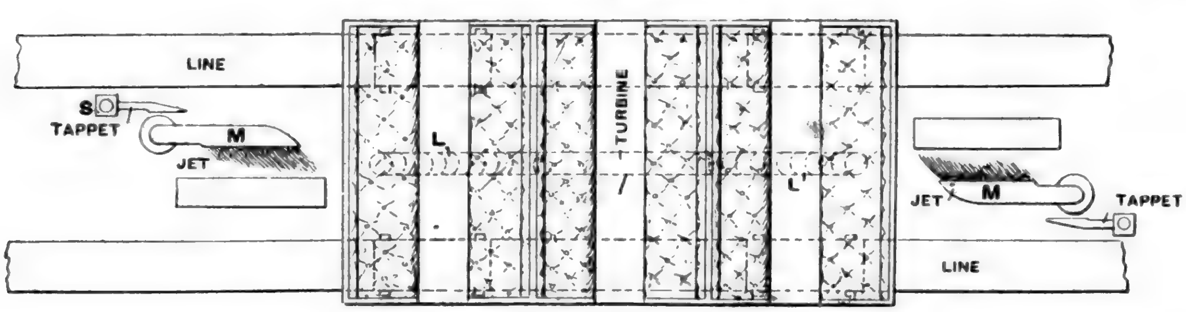


FIG. 8.

THE GIRARD HYDRAULIC RAILROAD AT THE PARIS EXPOSITION.

DETAILS OF CONSTRUCTION.

his death the invention was neglected for some years. A short time ago, however, one of his former colleagues, M. Barre, purchased the plans and drawings of M. Girard from his family, and having developed the invention, and taken out new patents, he formed a company to work them. The invention may be divided into two parts, which are distinct, the first relating to the mode of supporting the carriages, and the second to their propulsion. Each carriage is carried by four or six shoes, shown in figs. 3, 4, and 5; and these shoes slide on a broad, flat rail, 8 in. or 10 in. wide. The rail and shoe are shown in section in fig. 1. The rail is bolted to longitudinal wooden sleepers, and the shoe is held on the rail by four pieces of metal *A*, two on each side, which project slightly below the top of the rail. The bottom of the shoe which is in contact with the rail is grooved or channeled, so as to hold the water and keep a film between each shoe and the rail. The carriage is supported by vertical rods, which fit one into each shoe, a hole being formed for that purpose; and the point of support being very low, and quite close to the rail, great stability is insured. It is proposed to make the rail of the form shown in fig. 2 in future, as this will avoid the plates *A*, and the flanges *B* will help to keep the water on the rail. Figs. 3, 4, and 5 show the shoe in detail. Fig. 3 gives a longitudinal section, fig. 4 is a plan, and fig. 5 is a plan of the shoe inverted, showing the grooves in its face. Fig. 3 shows the hollow shoe, into which water at a pressure of 10 atmospheres is forced by a pipe from a tank on the tender. The water enters by the pipe *C*, and fills the whole of the chamber *D*. The water attempts to escape, and in doing so lifts the shoe slightly, thus filling the first groove of the chamber. The pressure again lifts the shoe, and the second chamber is filled; and so on, until ultimately the water escapes at the ends *E* and sides *F*. Thus a film of water is kept between the shoe and the rail, and on this film the carriage is said to float. The water runs away into the channels *H H* (fig. 6), and is collected to be used over again. Fig. 3 also shows the means of supporting the carriage on the shoe by means of *K*, the point of support being very low. The system of grooves on the lower face of the shoe is shown in fig. 5. So much for the means by which wheels are dispensed with, and the carriage enabled to slide along the line. The next point is the method of propulsion. Figs. 7 and 8 give an elevation and plan of one of the experimental carriages. Along the under side of each of the carriages a straight turbine, *L L*, extends the whole length, and water at high pressure impinges on the blades of this turbine from a jet, *M*, and by this means the carriage is moved along. A parabolic guide, which can be moved in and out of gear by a lever, is placed under the tender, and this on passing strikes the tappet *S* and opens the valve which discharges the water from the jet *M*, and this process is repeated every few yards along the whole line. The jets *M* must be placed at such a distance apart that at least one will be able to operate on the shortest train that can be used. In this turbine there are two sets of blades, one above the other, placed with their concave sides in opposite directions, so that one set is used for propelling in one direction and the other in the opposite direction. In fig. 6 it is seen that the jet *M* for one direction is just high enough to act against the blades *Q*, while the other jet is higher, and acts on the blades *P* for propulsion in the opposite direction. The valves *R*, which are opened by the tappet *S*, are of peculiar construction, and we hope soon to be able to give details of them. Reservoirs (fig. 6) holding water at high pressure must be placed at intervals, and the pipe *T* carrying high pressure water must run the whole length of the line. Fig. 6 shows a cross-section of the rail and carriage, and gives a good idea of the general arrangements. The absence of wheels and of greasing and lubricating arrangements will alone effect a very great saving. M. Barre thinks that a speed of 200 kilometers (or 124 miles) per hour may be easily and safely attained. Of course, as there is no heavy locomotive, and as the traction does not depend upon pressure on the rail, the road may be made comparatively light. The force required to move a wagon along the road is very small, M. Barre stating, as the result of his experiments, that an effort amounting to less than half a kilogramme (about 1 lb.) is sufficient to move one ton when suspended on a film of water with his improved shoes. It is recommended that the stations be placed at the summit of a double incline, so that on going up one side of the incline the motion of the train may be arrested, and on starting it may be assisted. No brakes are required, as the friction of the shoe against the rail, when the water under pressure is not being forced through, is found to be quite sufficient to bring the train to a standstill in a very sort distance. The same water is run into troughs by the side of the line, and can be used over and over again indefinitely; and in the case of long journeys, the water required for the tender could be taken up while the train is running. The principal advantages claimed for the railroad are: the absence of vibration and of side-rolling motion; the pleasure of traveling is comparable to that of sleighing over a surface of ice; there is no noise, and what is important in towns, there is no smoke and no dust is caused by the motion of the train during the journey; it is not easy for the carriages to be thrown from the rails, since any body getting on the rail is easily thrown off by the shoe, and will not be liable to get underneath, as is the case with wheels; the train can be stopped almost instantly, very smoothly and without shock; very high speeds can be attained; with water at a pressure of 220 lbs. a speed of 85 miles per hour can be attained; great facility in climbing up inclines and turning round the curves; as fixed engines are employed to obtain the pressure, there is great economy in the use of coal and construction of boilers, and there is a total absence of the expense of lubrication. It is, however, difficult to see how the railroad is to work during a long and severe frost.

THE MOUNT PILATUS RAILROAD.

As a supplement to the description of this remarkable railroad, given in the JOURNAL for September, we give the following details of construction:

The line is single-track, with the exception of a short piece at Aemsigen-Alp, where there is a second line of rails for the passage of the up and down trains. About one-half of the total length of line is straight, the other half being composed of curves, all of 80 meters (262.4 ft.) radius. There is one viaduct of 25 meters (82 ft.) span, and seven tunnels had to be made, varying in length from 9 meters (29.5 ft.) to 97 meters (318 ft.). The gauge is 0.8 meter ($31\frac{1}{2}$ in.), and the foundation for the rails and the central rack rail is formed of masonry, with coping of heavy granite slabs.

The locomotive, which had to be specially designed for this line, has its boiler placed at right angles to the line of rails in order to minimize the disturbance of water-level due to variations in the gradients. The pinions are driven by bevel gear from the main axles, and the cylinders are placed outside, with valve-chests inclined and below. The following are the principal data of these engines, which were built by the Swiss Locomotive and Machine Company at Winterthur, Switzerland: Diameter of cylinders, 0.220 meter (8.66 in.); stroke, 0.300 meter (11.81 in.); revolutions per minute for a speed of 1 meter per second, 180; heating surface of boiler 20 square meters (215.28 square ft.); working pressure, 180 lbs.; weight of locomotive and car empty, 5.7 tons; in service, 10.5 tons; pressure on rack on the 48° grade, 4.6 tons. The pinion-wheel which engages in the rack is 0.411 meter (16.2 in.) diameter, and has 15 teeth, the pitch being 0.0857 meter (3.374 in.). The car is 10.4 meters (34.11 ft.) long over all, and 2.2 meters (7.22 ft.) wide.

Three distinct brakes are provided: (1) an air-brake acting upon all the running wheels of the locomotive and car; (2) a hand-brake acting upon the axles of the locomotive; (3) a hand and automatic brake acting upon the two upper pinions through the intervention of clutches, worm, and worm-wheels. On the up journey the clutches are out of gear and the worms are at rest; but on the down journey the clutches are in gear and the worms are running at about 300 revolutions. The brake acts upon the worm spindle and can be tightened by hand. A centrifugal apparatus is, however, added, which puts this

brake on when the speed of the worm spindle exceeds 300 revolutions per minute.

The line has now been in regular work since the beginning of June last, and as regards safety and regularity of the service leaves nothing to be desired.

A FRENCH PASSENGER BOAT.

THE accompanying illustrations, from *Le Genie Civil*, show a small passenger boat—or, as it is called in Paris, an omnibus boat—built for use on the Seine by the Société des Magasins du Louvre.

In the illustrations fig. 1 is a general view; fig. 2 a longitudinal section; fig. 4 a plan, one-half showing the upper and one-half the lower deck; and fig. 3 is a cross-section.

In designing this boat two objects were kept in view, one being to make a vessel better in its accommodations than the ordinary small steamers used on the river; the second, to make a boat which would, from its model and decorations, be attractive to visitors to the Exposition.

With these aims, the boat was made on fine lines, in order to secure speed; the passenger accommodations were made unusually good, and much care was taken to make the decorations attractive to the eye.

The hull was built by the Société des Forges et Ateliers de St. Denis, and the engines by Boulet & Company.

The dimensions of the boat are as follows:

Length over all	31.00 meters	(101.68 ft.)
Length between perpendiculars	29.00 "	(95.12 ")
Extreme width on deck	5.20 "	(17.06 ")
Depth forward	2.30 "	(7.54 ")
" aft	2.40 "	(7.87 ")
Draft of water forward	1.40 "	(4.59 ")
" " aft	1.70 "	(5.58 ")
Area of immersed cross-section	3.92 sq. m.	(32.20 sq. ft.).

Compound condensing engine:

Diameter of high-pressure cylinder	0.280 meter	(11.02 in.).
" " low-pressure "	0.480 "	(18.90 ")
Stroke of cylinders	0.300 "	(11.81 ")
Revolutions per minute		200
Power developed		100 H. P.

The power is furnished by two multitubular boilers of the Terme & Deharbe type, the working pressure being 140 lbs.

The boat is entirely of iron. The ribs are spaced 19.68 in. apart, and there are five water-tight compartments in the hull.

The city ordinances limit the speed of boats on the Seine to 15 kilometers (9.3 miles) an hour; but this boat has shown itself capable of making a much higher speed.

The pilot is placed on the upper deck, forward of the smoke-stack; this arrangement, almost universal here, is a novelty in France, and is much commended for its convenience. The steersman is usually placed near the stern, and steers by signals from a lookout forward.

The upper deck is covered with an awning and is provided with fixed seats, arranged as shown in fig. 3; the lower deck, or cabin, has upholstered seats running around it. The cabin is provided with steam-pipes for heating in winter.

The boat is lighted with incandescent electric lights, the electric current being furnished by a Breguet continuous current machine, run by a separate engine. There are 24 lights, each of 16-candle power.

The decoration has purposely been kept as low as possible, in order not to interfere with the view from the decks. A mythological group of gilded swans is placed forward, apparently serving to hold up the awning and to support the staircase running to the upper deck. At the after end there is a baldaquin held up by another mythological group of dolphins and sea-nymphs. This ornamentation relieves the severity of the outlines of the boat, and is intended to imitate the decorations placed upon the ancient galleys. The general effect is said to be very agreeable.

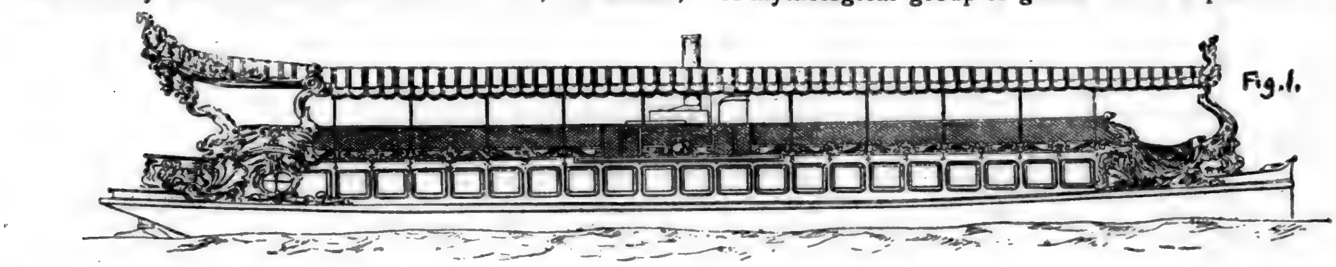


Fig. 1.

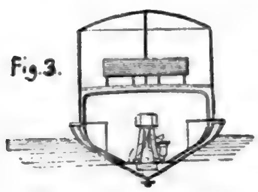


Fig. 3.

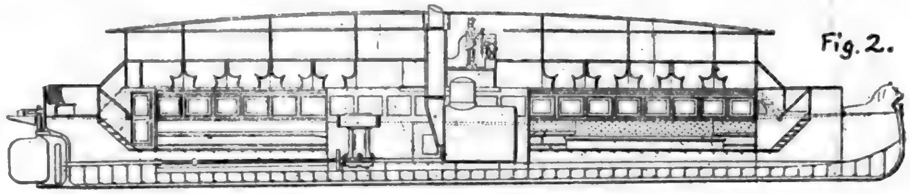


Fig. 2.

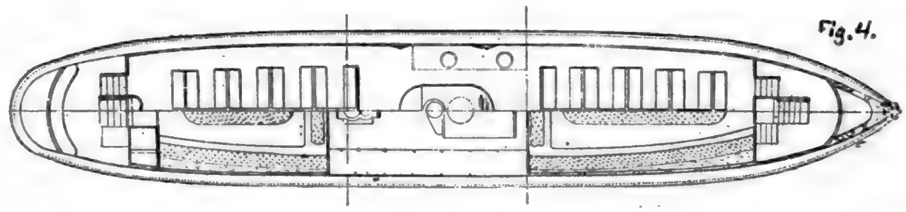


Fig. 4.

The electric lights in various parts of the boat are enclosed in gilded lanterns of Louis XIV. pattern.

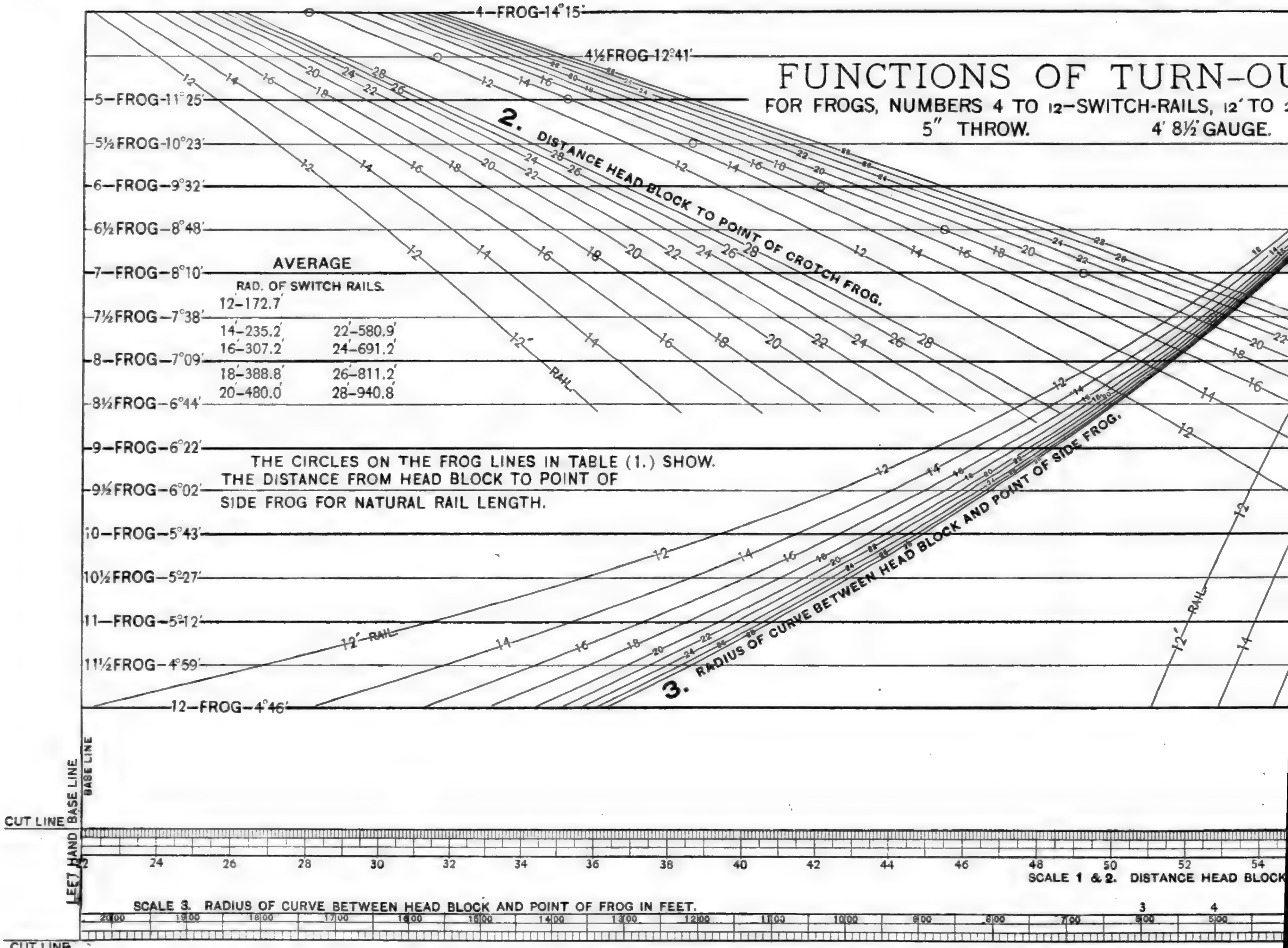
For a small boat, used only for very short trips, this seems to be an excellent pattern, although lacking in many of the conveniences we are accustomed to in this country even on our smaller steamboats. The hull and engine are worth examination, and there is something to be said in favor of the economy of space in the passenger arrangements.

This boat is now in service, plying on the Seine between the Bridge des Saints-Peres and the Bridge of Jena, and carrying daily a large number of passengers.

ELECTRIC RAILROADS.

[Abstract of paper read by G. W. Mansfield, before the National Electric Light Association.]

TO show the importance of the subject a table is given showing that there are in 26 cities of the United States 189 companies operating street lines; these include the elevated roads in New York and Brooklyn. These companies own 3,414 miles of track; 18,645 cars; 77,884 horses,



FUNCTIONS OF TURNOUTS.

By Frank S. Washburn.

(Copyright, 1889, by Frank S. Washburn.)

THE chart of railroad turnout functions, printed herewith, furnishes a rapid and easy way of obtaining all the measurements necessary to stake out ordinary stub-switch turnouts, single or double, for side frogs numbers 4 to 12, inclusive, and for switch-rail lengths 12 to 28 ft., inclusive. The special value of this chart lies in the fact that it provides for wide variations in the position of the frog with reference to its head-block.

The staking out of a railroad turnout, although ordinarily a simple matter, is the source of interminable disagreements between the young engineer, who depends solely upon his figures for the perfection of his work, and the roadmaster or track-foreman, who depends chiefly upon the accuracy of his eye. It is a subject of discussion in which the man of figures is generally beaten, not because he carries his mathematics too far, but because, by reason of the lengthy calculations involved, he does not carry his mathematics far enough. The engineer deals, ordinarily, with only one length of switch-rail for each size of frog, and hence, for each size of frog, he knows only one distance from heel of switch to point of frog. The trackman, in the course of long experience, has determined with more or less accuracy the effect which lengthening or shortening the switch-rail has upon the position of the frog, so that he can, within limits, place a frog anywhere with reference to its head-block, lay a curve between the point of frog and the head-block, and spike a switch-rail to fit; thus, while the turnout may be satisfactory, the measurements employed in staking it out may vary greatly from those furnished by the engineer. Whatever the result may be, it is convincing to but one party; the engineer has seen failures enough, in consequence of his figures not being followed, to warrant him in the belief that the trackman is wrong in ever varying from the standard measurements, while, on the other hand, the trackman knows of instances in which he has solved the problem of a troublesome connection economically and satisfactorily, by taking the best frog he could pick from stock, and placing it in the track regardless of the standard measurements. The most skillful eye and the best-tried rule of thumb, however, will often fail to get an easy-riding compound curve between the heel of switch and the point of frog. But even imperfect switch curves, and occasional derailments in consequence of their imperfection, are not sufficiently objectionable to balance the advantage of being able, in yards and cities, to lengthen or shorten the regular distance from heel of switch to point of frog. And so a satisfactory solution of the difficulty is to provide the correct measurements for laying out a turnout with the frog placed "anywhere." So far as the position of the frog is a function of the switch-rail length, all the necessary measurements can be accurately determined. These measurements have been calculated in the prepara
chart, and the graphical metho
in form easily understood and c

The chart gives, for any swit
from head-block to point of sid
block to point of crotch frog
head-block and point of side
curve between head-block and
number of crotch frog corresp
of side frog. It was assumed
form of a switch-rail, when thr
at one end and deflected 5 i
between the head-block and t
as the arc of a circle tangent
the switch-rail and tangent at
the frog. The approximate r
turnouts, contained in the upp
chart, are given, because they
enable one to be independent
where it is practicable to use th
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USE OF C

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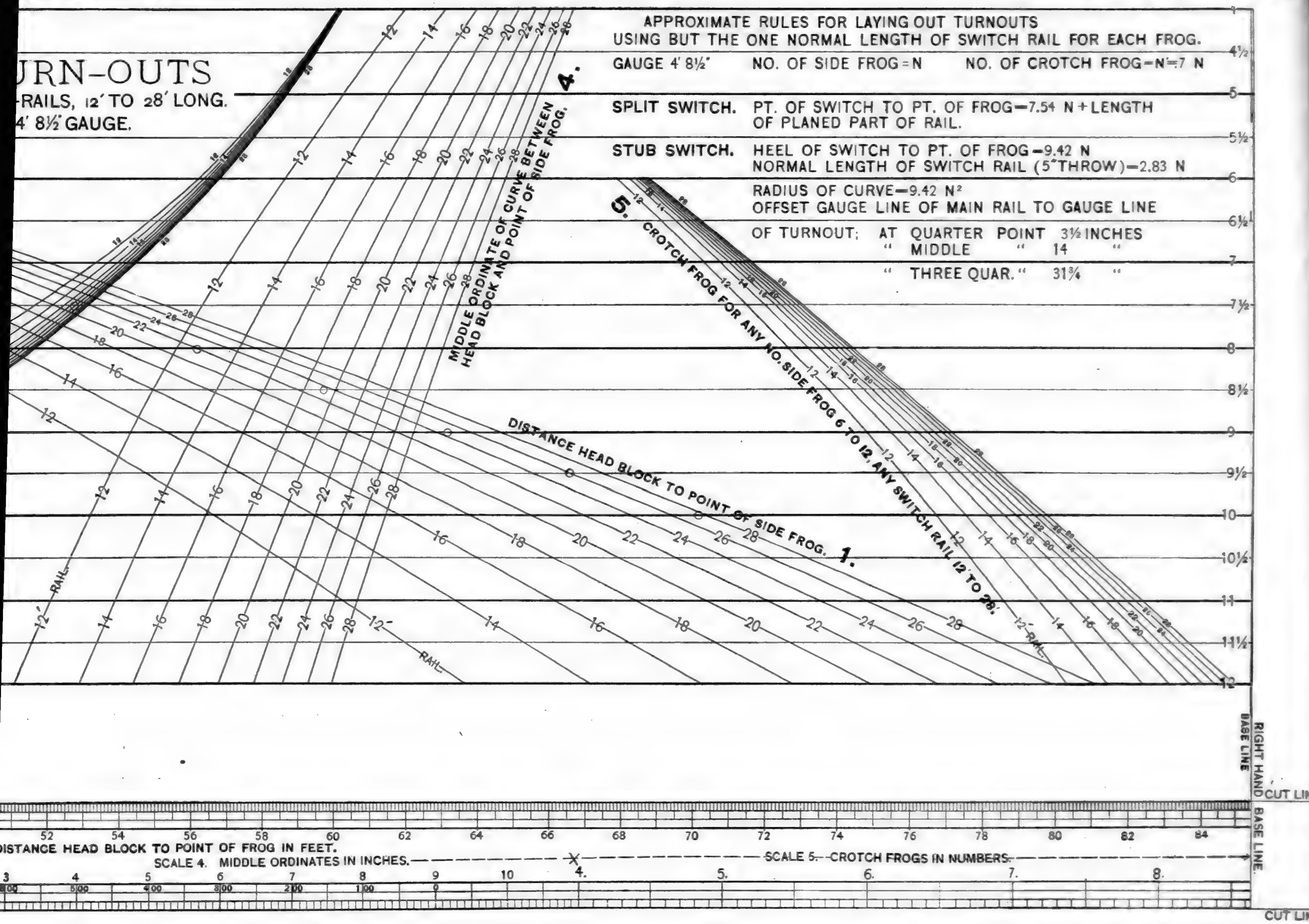


...ed in the preparation of the accompanying ...e graphical method of tabulation places them ... understood and of ready reference.

...gives, for any switch-rail length, the distance ...ck to point of side frog; distance from head- ...t of crotch frog; radius of curve between ...nd point of side frog; middle ordinate of ...n head-block and point of side frog, and the ...otch frog corresponding to a given number ... It was assumed in the calculations that the ...tch-rail, when thrown, is that of an arm fixed ...nd deflected 5 in. at the other. The curve ...head-block and the point of frog is taken ...a circle tangent at one end to the curve of ...l and tangent at the other end to the line of ...he approximate rules for the laying out of ...tained in the upper right-hand corner of the ...en, because they are easily memorized and ... be independent of tables in ordinary cases ...acticable to use the normal length of switch-

USE OF CHART.

...ecessary to cut the original chart sheet into ...s separating the scales from the diagrams. ...hould be cut out in one piece, along the two ...es designated as "cut lines." The horizontal ...he diagrams are read by means of the scales, ...same way as any scale. The vertical ordi- ...l by means of the horizontal lines of the dia- grams, upon which are marked the frog numbers. In using the chart care should be taken that the base lines of the scale sheet correspond with the base lines of the diagram sheet. The distances given by diagrams 1 and 2 are to be measured on the main track; the distances given by diagrams 3 and 4 apply to the outside rail of the turnout curve.

1. To determine the distance from head-block to point of side frog, for any given frog number 4 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Place the edge of Scale 1 and 2 along the horizontal line whose number corresponds to the number of the given side frog, and read the scale, in feet and tenths, where it intersects, in Diagram 1, the line whose number corresponds to the given length of switch-rail. Diagram 1 extends from near the upper left-hand corner of the chart to near the lower right-hand corner, and is marked "Distance head-block to point of side frog."

2. To determine the distance from head-block to point of crotch frog, for any given crotch frog number 4 to 8½, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Place the edge of Scale 1 and 2 along the horizontal line whose number corresponds to the number of the given crotch frog, and read the scale, in feet and tenths, where it intersects, in Diagram 2, the line whose number corresponds to the given length of switch-rail. Diagram 2 extends from the upper left-hand corner of the chart diagonally half-way across the chart, and is marked "Distance from head-block to point of crotch frog."

3. To determine the radius of the curve lying between the head-block and the point of side frog, for any given side frog number 4 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Use Scale 3 with Diagram 3 in the same manner as directed for the use of other scales and diagrams. Scale 3 is on the opposite side of the scale strip from Scales 1 and 2. Diagram 3 extends from near the middle of the top of the chart to the lower left-hand corner, and is marked "Radius of curve between head-block and point of side frog."

4. To determine the middle ordinate of the curve lying between the head-block and point of side frog, for any given side frog number 4 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Use Scale 4, reading it in inches and tenths, with Diagram 4. Scale 4 is superimposed on the right-hand end of Scale 3. Diagram 4 occupies the middle of the chart, to the right of Diagram 3, and is marked "Middle ordinate of curve between head-block and point of side frog."

5. To determine the number of crotch frog, for any given side frog number 6 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Use Scale 5, reading it in frog numbers and tenths, with Diagram 5. Scale 5 is on the right of Scale 3 and Scale 4. Diagram 5 extends from the lower right-hand corner diagonally half-way across the chart, and is marked "Crotch frog for any number of side frog 6 to 12, any switch-rail 12 ft. to 28 ft."

Interpolation should be resorted to for odd numbers of frogs or odd lengths of switch-rails.

and 528 locomotives and other motors; they carried last year 1,434,057,595 passengers.

In 1885 there were three electric railroads having $7\frac{1}{2}$ miles of track and 13 cars. The figures on July 1, 1889, were as follows:

	In operation.	Building.	Total.
Electric railroads............	19	42	61
Miles of road................	113	267	380
Number of cars..............	174	364	538

This does not include the West End Company, of Boston, which is making arrangements to supply its 1,584 cars with the electric motor.

In meeting the demand for better city transit there are many considerations claiming the careful attention of the electrician. The conditions to be met with are widely different from all other electrical applications. Essentially there is: 1. A steam engine. 2. A dynamo. 3. A conductor. 4. A motor mounted on a vehicle and subjected to mechanical and physical conditions more extreme and severe than have heretofore been imposed upon any electrical machinery. The engine, of course, has to stand the hardest work.

Owing to the nature of the work itself the amount of power called for is very variable. In one instance cards taken at short intervals from an engine running a busy line showed a variation from $15\frac{1}{2}$ to 121 H. P. in the power exerted. Under these circumstances, the question of coal economy is a troublesome one, and, moreover, the amount of repair needed is increased. The larger the road, however, the less the variation will be, comparatively, and the more economically the engine can be run.

Almost the first question asked by the manager of an electric light company when an application has been made to him for power, is: "How much electric power must I allow per car?" No man can give a definite answer to this question that will meet all conditions.

If the following facts are known, a fair judgment can be made: 1. Number of cars simultaneously operated. 2. Speed and nature of service. 3. Maximum grade, and number of grades. 4. Scheduled location of cars in reference to grades. 5. Motor cars to be used to tow other cars or not. 6. Any peculiarities in regard to the distribution of cars. 7. Condition of track. 8. Location of track in reference to power house.

On a portion of the Cambridge Division of the West End Company's road, of Boston, the Thomson-Houston Company's motors commenced running February 16, 1889. Up to July 1, 165,781 miles and 25,505 round trips had been made with a loss of but 325 miles, or 0.19 per cent. (49 round trips). During this time nearly 1,500,000 passengers were carried. This, in view of the fact that during the entire time one, and part of the time two tow-cars were drawn, is remarkable.

On a portion of the route there is an open bridge about 1,800 ft. long, on which is located one draw, which is opened from 20 to 30 times a day. Over this bridge 1,810 cars per day pass, or on the average of one every three-quarters of a minute, and at some portions of the day they run at half-minute intervals. The teaming on this street is also very heavy, necessitating constant stopping. You will see from these figures what the loss of current or a motor burn-out causing delay would mean. The record, however, has been magnificent. As the dynamos are run by the Cambridge Electric Light Company, and are so arranged that the same engines furnish power and lights for their own purposes, as yet only approximate data as to the fuel consumption, etc., has been possible. A few electrical tests have been made. Ammeter and voltmeter readings were taken at the station every 15 minutes, four readings per minute, or at 15 second intervals. This was kept up from 6.30 A.M. to 12.30 A.M. next morning for five days. In all, 1,480 readings were taken. The average of these readings gave, for 12.6 cars in continuous service, 111.6 ampères, 500 volts, or 74.8 H. P. Per car this is 8.8 ampères and 5.9 electrical H. P. The average number of passengers carried was about 58 per round trip. There are now 32 cars in operation, and observations, in so far as they have been taken, show a marked decrease in H. P. per car. At Richmond, Va., some rough tests gave the electrical H. P. required per car at the station as from 4 to 5. On the road at Lafayette, Ill., the figures of Dr. Bell show the remarkably low figure of 2.5 electrical H. P. There are a number of circumstances on this road that would tend to make this figure so low. The cars are smaller than those ordinarily used, and I should judge that there were other circumstances entering into the calculation that would tend to reduce it. However, it well shows, possibly, one extreme in railroading.

The other extreme might be cited in the case of the Lynn Road, Highland Division. Here only one car is in operation. In the course of its route it ascends a hill graded at the rate of 8.7 per cent. for 300 ft., and immediately passes down on the other side. In this case the engine was indicated. Five cards were taken when the car was ascending the grade, the average of which was 52.2 H. P. If we allowed a dynamo efficiency of 90 per cent., this would indicate an electrical horse-power of 47 H. P. This is unquestionably a very extreme and exceptional case. I might add, incidentally, that the car pays handsomely.

At Plymouth, Mass., a road having many heavy grades, the maximum being over 10 per cent., and operating but three electric cars, each with tow-cars, the electrical horse-power at the station per car was approximately 7.72 H. P. On the cars the extremes vary obviously, according to speed, grades, load, etc. It frequently reaches from four to five times the average value during the total time. In Lynn the variation is enormous. In Cambridge the current frequently rises to from 65 to 70 ampères, or about 42 H. P. Especially is this the case on starting You can see from these figures the impossibility of giving the most approximate figures in this direction unless every detail as to operation and conditions is known. I feel, however, that on roads having no grades over 5 per cent., and operating under 10 motor cars, with tow-cars, 15 H. P. per car would be a safe figure for dynamo capacity. On large roads this figure could be reduced to 12 and possibly 10 H. P. per car, while on small three or five-car roads, with heavy grades, 18 or 20 H. P. might not be any too much.

From estimations based upon many figures, I feel certain that a total electrical efficiency of at least 70 per cent. can be obtained, and a total commercial efficiency measured from the indicated horse-power of the engine to the car-wheel horse-power (W. H. P.) of from 45 to 50 per cent. If the road-bed, rolling-stock, and all the electrical apparatus is maintained as it should be, I see no reason why this figure cannot be exceeded.

There is one point which is of vital interest to the managers of electric light companies, and this is how they shall charge the railroad companies for power. I have already shown you that it is an exceedingly difficult thing to estimate upon the requisite power, as the conditions are so fluctuating and so variable. After, however, the question of the amount of power has been settled, the next point to determine is whether they shall charge the railroad company by the hour, by the day, or by the car-mile. We have a large number of roads already hiring power of local companies; all of the methods just mentioned are in use. Upon small roads, where the schedule of the railroad company is such that they have only a few cars running continuously, meeting emergencies by extras, and where the grades are heavy, a satisfactory basis has been to charge so much per day per car, the price ranging all the way from $3 to $5, $6, and even $7. When the roads are of moderate size, or are subject to many variations and sudden demands on the part of the public for better facilities, or when the line runs to some resort and the main bulk of business lies in picnics, etc., charges on the hour basis is sometimes preferred. This price varies from 15 to 30 cents per hour. On larger systems, where the schedule is definite and fixed, the mileage basis is the preferable by far. The prices on this basis range from two to six cents.

In the East, where coal ranges from $4 to $5 per ton, naturally the prices could not compete with the railroads of the natural gas and coal regions, where fuel can be obtained for almost nothing, in some cases for 10 cents per ton.

I would like now to enter a wedge here in favor of the very best of construction. Your own experience has probably dictated that there is no economy if the original con-

struction be put in with either inferior or faulty material or apparatus. It is most important that the overhead construction, the track-circuit, the wiring of the cars, and all other details be as perfect as it is possible for the best skill and brains to make them. If the light companies would require proper and reasonable guarantees in this direction, whenever they do supply power, it would not only be a surety for their own protection, but would be a strong inducement for the very best of construction work. The railroad man should see that it is for his interests, since there is nothing that will consume profits so rapidly as break-downs.

In conclusion, the possibility and economy of combining electric light stations and power plants is urged, especially for smaller cities.

JAPANESE RAILROADS.

As an addition to the table of Japanese railroads published in the September JOURNAL, we give below the amount of the capital of the several companies, with the mileage each is authorized to build :

Company.	Mileage.	Capital.
Niphon Railroad Company	529.00	$20,000,000
Mito Railroad Company	41.35	1,200,000
Ryomo Railroad Company	52.00	1,500,000
Kobu Railroad Company	21.00	900,000
Iyo Railroad Company	4.00	40,000
Hankai Railroad Company	6.21	330,000
Sanyo Railroad Company	302.25	13,000,000
Osaka Railroad Company	37.00	1,800,000
Sanuki Railroad Company	10.00	250,000
Kansei Railroad Company	72.00	3,000,000
Kiushiu Railroad Company	271.23	11,000,000
Total	1,346.04	$53,020,000

In addition to the capital of these companies, the amount of money spent on the Government railroads has been in all about $35,000,000.

Besides the lines actually built or under construction, there are 15 lines projected, for which concessions have not yet been granted. The total length of these projected railroads is about 700 miles, and the proposed capital is about $30,000,000.

In the city of Tokio there are now 15 miles of street railroads. The rails used are of the trough-shaped pattern, weighing 37 lbs. per yard. The rails are laid on longitudinal sleepers and cross-ties ; the gauge of the roads is 4 ft. 6 in. The cars are run at the rate of about 5 miles an hour. On these lines there are 62 cars in use ; they were all built by the John Stephenson Company, of New York.

UNITED STATES NAVAL PROGRESS.

MENTION has heretofore been made of the fact that some of the new guns for the Navy were to be mounted on pneumatic carriages. From the latest number of the *Naval Intelligence* series, issued by the Navy Department, we take the following description of the pneumatic carriage for the 8-in. breech-loading rifled gun, and the accompanying illustration :

In this carriage, designed and built for the Navy Department by the Pneumatic Gun Carriage & Power Company, the gun is mounted in the ordinary manner by its trunnions in bearings formed in a top carriage, A, which hooks under flanges A^1, formed on the top of the slide A^2, and moves horizontally on recoil instead of up an incline, as in carriages of the ordinary hydraulic type. The reason for this is hereinafter explained. At the front the cheeks forming the slide are connected by a transom, A^3, and secured to a bed-plate, B, provided with brackets B^1, in which are pivoted three truck rollers B^2. The rollers have grooves which work over a projection of corresponding shape formed on a circular bed-plate, B^3, which supports the front of the carriage and the weight of the gun when in battery. In the center of this circular plate (which is secured to the deck of the vessel), and also in the bed of the carriage, is formed a bearing, B^4, for a pivot around which the carriage turns. On the circular bed B^3 is a projecting flange, under which the clips B^5 hook to prevent the carriage from lifting The rear end of the carriage is secured to a transom, C, in which are pivoted four truck rollers, two being placed under each cheek of the slide ; these rollers also have grooves which fit over a projection on the circular traversing ring D, provided with a projecting flange for clipping down the rear end of the carriage. To two downward projecting arms E on the top carriage are secured piston-rods and pistons E^1, which work in the pneumatic recoil cylinders E^2. Each recoil cylinder and its cheek are cast in one piece, and the tops of the cylinders are made on a line with the tops of the cheeks, so as not to interfere with the sighting of the gun. These recoil cylinders are supplied with compressed air by a pipe communicating through the pivot with a reservoir and air compressor by pipe G and stationary manifold G^1. The pistons are solid, without packing, and made less in diameter than the bore of the cylinders to allow of a displacement of a portion of the air by the recoil of the gun and pistons, thus forming nearly an equilibrium of pressure on both sides of the pistons at the termination of the recoil. The excess of pressure caused by the different areas of the cylinder on each side of the piston gradually runs the gun into battery, dispensing with the necessity of inclined slides, a matter of great inconvenience in a rolling sea.

This carriage is worked mechanically by means of a small air engine, H, located in the front portion of the carriage and provided with a follow-up stop-motion valve operated by the hand-wheel H^1. The traversing of the carriage is performed by the engine through the medium of reversible clutch-gears operated by the hand-lever H^2, in connection with a worm-gear, shaft, pinion, and rack formed on the inside of the circular traversing ring D. The traverse of the carriage ceases the moment that the turning of the hand-wheel H^1, which controls the valve of the engine, is stopped.

The elevating and depressing of the gun is performed by means of two horizontal bars which are parallel with the slides of the carriage and are connected to the gun by saddles and the elevating band I. These bars are elevated by vertical racks I^1, which work in grooves in the cheeks of the carriage. Into the vertical racks engage pinions carried by horizontal shafts, which are supported by bearings I^2 formed on the cheeks of the carriage, the shafts and pinions being worked by friction worm-gears and reversible clutch-gears operated by the reversing lever K. This gearing is actuated by the air engine, which receives its air supply of compressed air by a communication through the pivot, the manifold M, and pipe M^1. The exhaust is through the pipe M^2. The pivot revolves with the carriage, so as not to derange the pipes in the carriage, while the manifolds are stationary, so as not to derange the pipes leading to the air receivers.

The carriage can be traversed and the gun elevated or depressed by hand, and the operations can be performed simultaneously or singly as may be required, while the engine remains idle. The initial pressure requisite to take up the recoil of the gun varies from 250 to 400 lbs. per square inch.

This carriage has been built by authority of Congress on the recommendation of the Secretary of the Navy (June, 1886). Its weight complete without the gun is about 16,000 lbs., and in future 8-in. carriages the weight is expected to be reduced to 14,000 lbs.

The trial of this carriage took place at the naval proving ground at Annapolis. The gun mounted upon it was an 8-in. B. L., mark II. ; the powder charge was 126 lbs. of Dupont's brown prismatic powder ; the weight of projectile, 250 lbs. ; and the powder pressure obtained on two rounds was 16.17 and 16.79 tons. The weight of the carriage as given by the contractors, including pivot sockets and tracks, is 16,400 lbs. ; the outside dimensions are : length, 7 ft. ; width, 5 ft. The gun was fired at level with the exception of one round at 14° and three other rounds at 5° elevation.

Two deliberate rounds were first fired, and the rapidity test of 10 rounds was then begun. Three rounds were

fired in less than five minutes, when the pinion on the lever of the breech-plug gave way, and the trial was adjourned until the broken part could be replaced. When continued, seven rounds were fired in 8 minutes 16 seconds.

During the trial 20 rounds were fired, and previous to this some 11 rounds had been fired with various charges. At the end of the trial the carriage showed no spread or other signs of distress.

The recoil varied between 23¼ and 24¼ in., the air pressure in cylinders being kept at about 330 lbs. by the continuous action of the air compressors. It was shown that with this carriage the pressure in the recoil cylinders fell 100 lbs. in five minutes when the air compressors were shut off.

The pneumatic loading apparatus worked efficiently, and the training, elevating and pointing of the gun were well accomplished, but could be improved by increased rapidity.

LAUNCH OF THE "PHILADELPHIA."

The naval event of the past month was the launch of the *Philadelphia*, which took place September 7, at the Cramp yard in Philadelphia.

The *Philadelphia* resembles nearly the *Baltimore*, and is an unarmored steel cruiser of 4,400 tons displacement, 335 ft. long, 38½ ft. in width, and 16¼ ft. mean draft. Though without side armor, she has a protective deck, varying in thickness from 4 in. over the engines to 2 in. at the extreme ends, and the coal bunkers are so arranged as to protect the machinery. The ship is divided into numerous water-tight compartments, and has the latest approved arrangements for ventilation, electric light, etc.

She has three masts, provided with fighting tops, carrying mounts for machine guns. The masts will be rigged for fore-and-aft sails, but the sails will not be relied on for motive power, being only sufficient to steady the ship in heavy weather.

The *Philadelphia* has twin screws, each driven by a separate triple-expansion engine, with cylinders 38 in., 56 in. and 86 in. in diameter and 40 in. stroke. The engines are supplied with steam by four boilers, each 14 ft. in diameter and 20 ft. long.

With forced draft the boilers will carry 160 lbs. pressure, and the engines are expected to work up to 10,500 H. P. The guaranteed speed is 19 knots an hour.

There are several auxiliary engines, which will run the pumps, ventilators, dynamos, etc.

The main battery will consist of twelve 6-in. breech-loading rifled guns, two mounted forward, two aft and eight in broadside. The broadside guns will also have a considerable fore-and-aft range. The secondary battery will include a number of smaller rapid-fire and machine guns, and there will be also five torpedo-tubes, mounted two in bow, one aft and two in broadside.

OTHER NEW SHIPS.

None of the bids received for the three 2,000-ton and the two 3,000-ton cruisers came within the requirements of the Navy Department. For the 2,000-ton ships two bids were received, the Bath Iron Works, of Bath, Me., offering to build them for $780,000 each, but requiring two years and six months time instead of two years. The William Cramp & Sons Ship & Engine Building Company, Philadelphia, offered to build the same vessels for $875,000 each. For the 3,000-ton ships only one bid was received, the Cramp Company offering to take them at $1,225,000 each. As the limits set by law were $700,000 and $1,100,000 respectively, none of the bids could be accepted.

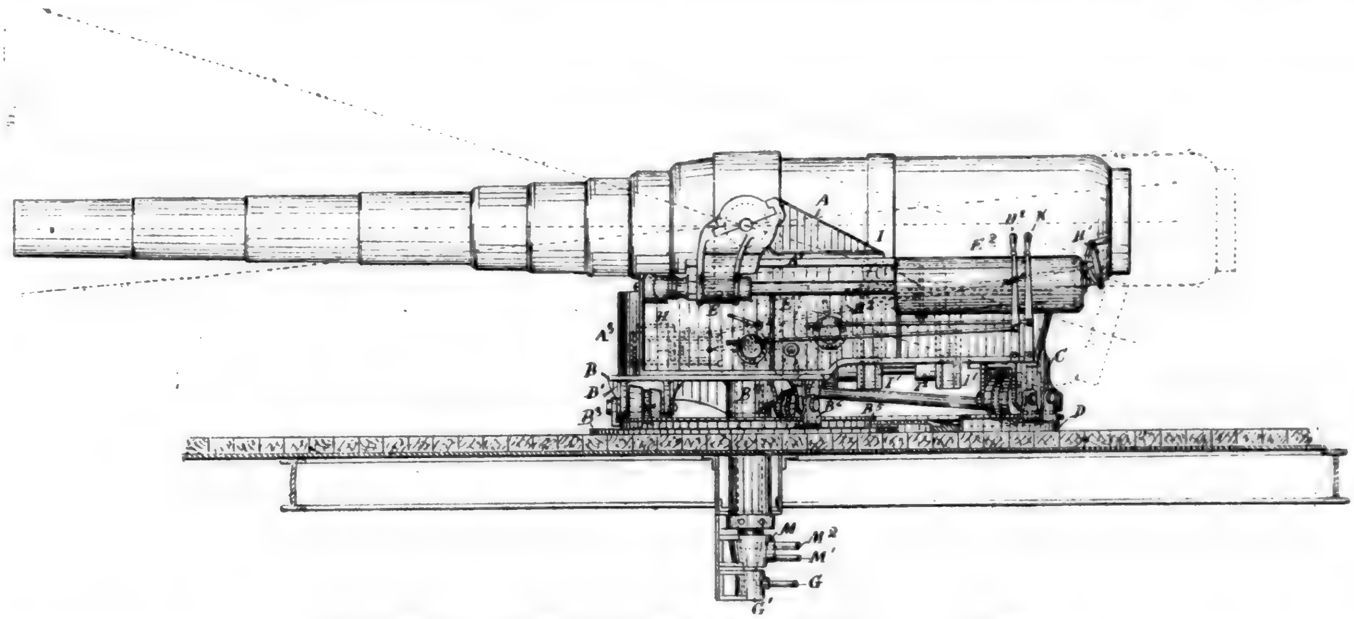
New bids have been called for, and will be received until October 26. In these the conditions are somewhat modified. In the first place, the time is made two years six months instead of two years; the minimum speed has been reduced from 18 to 17 knots an hour, and the ships will not be rejected unless they fall short of 16 knots. There will be a premium of $25,000 for each quarter-knot over the prescribed speed, and a penalty of $10,000 for each quarter-knot below it. It is hoped that, with these changes, more bids will be put in. These new bids are for the three 2,000-ton cruisers. The Secretary of the Navy has decided to build the two 3,000-ton ships in the Government yards; one probably at the New York and one at the Norfolk Navy Yard.

A board has been appointed to consider and, if necessary, to revise the plans for the armored battle-ship *Texas*. It is said that increases in the armament have added so much to the weight of the vessel that she will be entirely too low in the water if the present plans are carried out. The remedy proposed is to lengthen the ship about 30 ft., thus increasing her buoyancy as much as may be needed.

The *Charleston*, on the Pacific Coast, and the *Petrel* in the East have had preliminary trials, both doing very well. Their final trials are yet to come.

The *Yorktown* has been tested pretty thoroughly as to her ability in manœuvring at sea, and also to some extent as a cruiser. The results have been satisfactory. The *Boston* has also been tried in a similar way.

The official speed trials of the new cruiser *Baltimore* took place in Chesapeake Bay September 14. The trials were certainly very thorough, for they took place under somewhat unfavorable conditions of wind and weather, the sea being very rough, high winds blowing at the time, and the water being very rough. Under the terms of the contract, the *Baltimore* was to develop at least 9,000



PNEUMATIC CARRIAGE FOR 8-IN. GUN, U. S. NAVY.

H. P., and the builders were to receive a premium of $100 for every horse-power developed over that figure. The average speed of the *Baltimore* on the four hours' run was 19.8 knots per hour with forced draft, the screw making 110 revolutions a minute, and the boilers carrying an average pressure of 118 lbs. At times the number of revolutions ran up to 112, and the speed was as high as 20.2 knots per hour. The official report has not yet been made, nor have all the calculations made from the indicator diagrams been worked out; but there is no doubt that the *Baltimore* passed the speed trial very successfully, and that her builders will receive a considerable bonus over the contract price. The trials of the ship in turning, steering, etc., were also very successfully passed.

PLANS FOR NEW SHIPS.

The last Congress authorized the building of two large vessels, one of 5,300 tons and one of 7,500 tons displacement. Plans for these ships have been agreed on and submitted for approval.

The 5,300-ton ship will be of steel, 315 ft. long and 50 ft. beam; she will have twin screws and triple-expansion engines capable of working up to 11,000 H. P. She is required to develop a speed of 20 knots an hour. This ship will be a protected cruiser, and will carry a main battery of 10-in. and 12-in. guns, with a formidable secondary battery.

In general design this ship will resemble the famous Spanish cruiser *Reina Regente*, which was described and illustrated in the JOURNAL for December, 1887, page 557.

The larger, or 7,500-ton vessel will be an armored battle-ship of steel, 315 ft. long and 62 ft. beam. She will be built of steel and armored with steel, and will carry a heavy battery, composed of 12-in. and 16-in. guns, with the usual secondary battery. Although so much heavier than the cruiser, her engines are designed to work only up to 10,000 H. P., and the extreme speed will not exceed 17 knots. There will be two triple-expansion engines, driving twin screws. The general design resembles that of the English *Warspite* class.

The authorized cost of the 5,300-ton cruiser is $1,800,000, and of the 7,500-ton battle-ship $3,500,000, both exclusive of armament.

EXPERIENCE WITH METALLIC TIES.

M. MAYER, Chief Engineer of the Western Railroad of Switzerland and the Simplon Railroad, has recently submitted to the Executive Commission of the International Railroad Congress an interesting report on the use of metallic ties, which is translated below. The report is in the form of answers to a schedule of questions sent out by the Commission; for convenience, the questions are omitted in the translation, their nature being sufficiently indicated by the text.

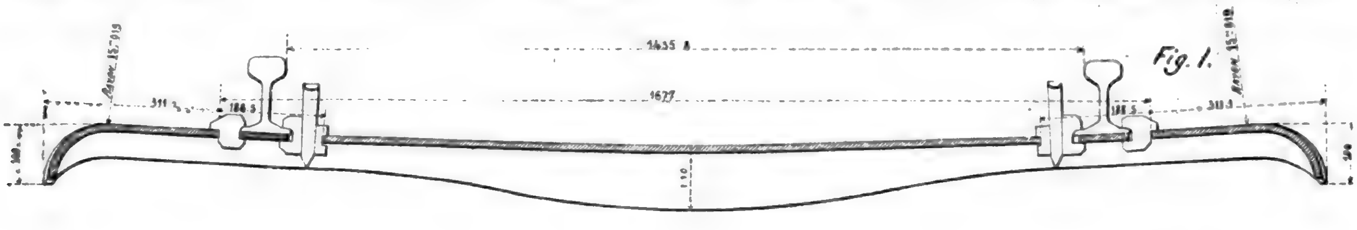
Since 1883 metallic ties have been used on these lines in current practice; that is, a considerable part of the renewals on all sections of the company's system have been made with metal ties.

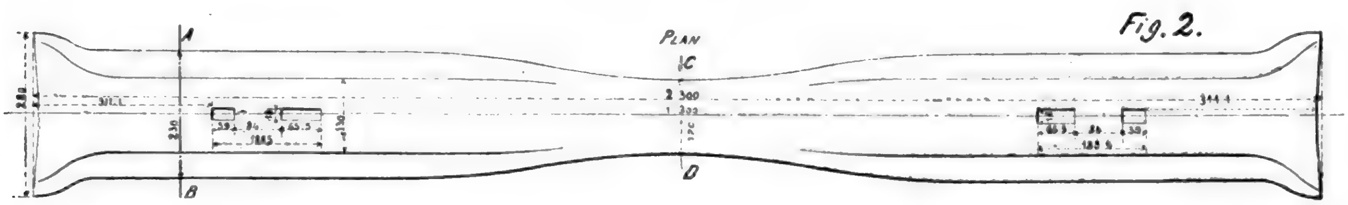
The total length of line thus renewed has been:

	Kilometers.	Miles.
1883	10.867	6.753
1884	17.299	10.750
1885	16.341	10.154
1886	15.341	9.533
1887	21.025	13.065
1888	29.719	18 467
Total	110.592	68.722

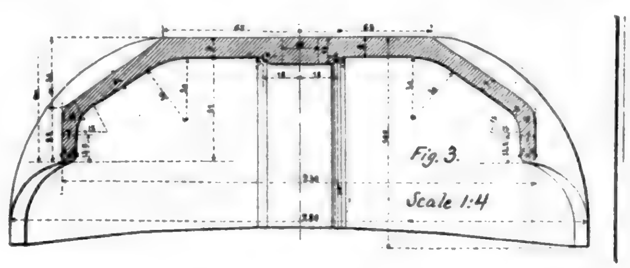
This represents a total of 126,990 metal ties put in the road. The company is continuing the work, and expects to put in these ties at the rate of 25 to 30 kilometers (15 to 19 miles) yearly. Their use is no longer an experiment, but the regular standard of the road.

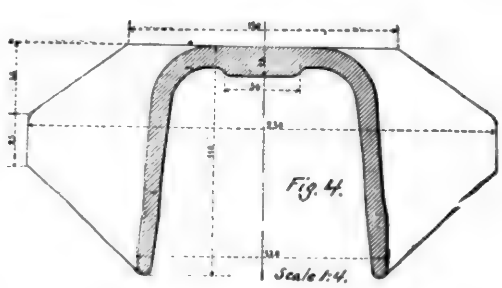
The ties used are of the Hilf system—first introduced on the Berg & Mark Railroad in Germany—with rail-fastenings consisting of clamps and wedges. The pattern now in use was adopted in 1887; it differs from that originally introduced in 1883 in being drawn in at the center and flared out slightly at the ends, the old pattern having been straight for its whole length. The object of the change was to give the tie a better hold on the ballast, and to prevent lateral movement.





The accompanying illustrations show the standard pattern now in use. Fig. 1 is a longitudinal section; fig. 2 a plan; fig. 3 a cross-section on the line *A B*, fig. 2; fig. 4 a cross-section on the line *C D*, fig. 2; and fig. 5 a cross-section of the rail, showing the fastenings.





These ties are all made of homogeneous iron (*Flusseisen*) or of mild steel, having a resistance of from 56,000 to 63,000 lbs. per square inch to breaking; they weigh 45 kg. (99.18 lbs.) each.

As to the conditions to which they are subjected, the grades on the company's lines are in some cases as high as 2.3 per cent. (121.44 ft. per mile); the minimum radius of curvature is 350 meters (1,148 ft.). The traffic, of course, varies on the different branches, the lowest having 8 and the highest 30 trains a day in each direction. The maximum speed is from 28 miles an hour on the less important branches up to 40 miles on the main line from Geneva to Lausanne.

The maximum weight of locomotives is 34 tons, the maximum weight per axle being 12 tons, or 6 tons per wheel. There are a few old four-wheel tank engines in use, which have a weight of 13 tons per axle.

The rails, as shown in fig. 5, are of the flat-footed or Vignoles pattern, the standard rail used on all lines weighing 65 lbs. per yard. Up to 1884 they were made 6 m. (19.68 ft.) long, and seven ties were laid to a rail. Now the rails are all made 12 m. (39.37 ft.) long, and 13 ties—in some cases 14—are laid to a rail.

In most sections gravel ballast is used, the gravel being entirely free from sand or large stones. On some sections, however, broken stone is used for ballast, the standard size being 4 cm. (1.57 in.). By way of trial some ties have been laid on old ballast of gravel and sand.

As to first cost, a section of 12 m. (rail-length) on new oak ties costs at present $47.05, or say $1.195 per running foot; with steel ties the cost is $47.54, or $1.207 per running foot; the difference being thus very small. This cost is based on the prices paid at the present time, which are about 87 cents each for oak ties; for the iron ties, $1.16 each, with 15 cents for the rail fastening, making a total of $1.31 each.

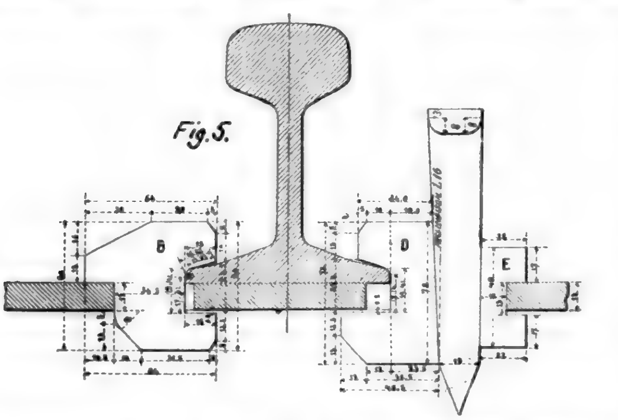
As to the comparative cost of maintaining track with wooden and with metal ties, more experience is needed to determine. However, it may be said that a return made for the year ending with February, 1889, for 43 sections of track, 21 on wooden ties and 22 on metallic ties, showed that the expense of maintaining the track on the metallic ties was slightly less than on the wooden ties.

The company's experience is that the cost of keeping the track in order with metallic ties is generally equal to or a little higher than with wooden ties the first and second year after they are laid; after the second year there is a notable decrease in cost with the iron tie.

As to the life of iron or steel ties, there is not yet experience enough to speak with any degree of certainty. It may be remarked that the iron ties laid in 1883—the first put down on the Western Railroad—do not show any wear of the upper surface, nor any cutting by the rail. A few of the clamps and wedges used in fastening the rails have been taken out, not on account of failure, but because they were considered too light, and were replaced by new ones of better design.

As far as the effect on rolling stock is concerned, no perceptible differences have been noted. In running over the

Fig. 5.



iron ties in passenger trains a peculiar metallic sound is heard. It is so slight, however, as hardly to be noticed by any one who is not listening for it carefully.

One of the results noted has been a decrease in the price of oak ties, which has fallen from $1.25 to 87 cents since the company began to put in metal ties.

It may also be noted that, while sufficient time has not yet passed since the introduction of metal ties on the Western Railroad of Switzerland to determine their average life, of the 126,990 ties laid down since 1883, only 43 ties—or 0.339 per thousand—have been taken out on account of breakage. With the same number of oak ties from 20,000 to 25,000 would have been taken out and replaced by new ones. This is regarded as conclusive in favor of their durability.

The results have been in general so favorable that, as noted above, the company has adopted the metal tie as its standard, and is putting them in on from 25 to 30 km. (15 to 19 miles) a year. Contracts for a supply for five years at this rate have been let.

Statistics furnished by the other Swiss railroads, while they do not give absolutely identical results, are all favorable to the use of metallic ties.

The Central Railroad Company of Switzerland uses ties of the same pattern—Berg & Mark—as the Western Company, but somewhat heavier, weighing 55 kg. (121 lbs.) each. On this road the cost of maintenance of a section 12.9 miles in length, for the third year after the iron ties had been laid, was $869, as against $1,563 with wooden ties—a decrease of 44½ per cent.

On the Gothard Railroad iron ties of the same pattern have been in use for five years. The pattern is the same as that described above; those first laid weighed 45 kg. (99 lbs.), but the weight has been increased to 58 kg. (127.8 lbs.). On this road the expenses of maintenance (not renewal) are slightly greater with iron ties. The ballast used is all broken stone.

The Northeastern Railroad of Switzerland has used a large number of iron ties of the Roth-Schuler pattern, the rail being fastened with a chair and bolts; the ties weigh 53.5 kg. (118 lbs.) each. The result has been a marked reduction in cost of maintenance.

Switzerland is a mountain country, where the railroads have numerous heavy grades and sharp curves, where extreme temperatures are experienced and where obstructions from snow are frequent. While in some other countries the traffic may be heavier, this seems to be peculiarly adapted for a thorough and severe test of the metallic tie; and such a test is now being made.

ELECTRIC-LIGHT INSTALLATIONS FOR UNITED STATES CRUISERS.

(Lieutenant T. E. DeWitt Veeder, U. S. N., in *Naval Intelligence*, No. VIII.)

MANY of the difficulties that have been experienced in electric-light installations generally have arisen from the use of inferior materials, the employment of inferior workmen, and, in consequence, inferior workmanship, and to the fact that there have been few, if any, conditions imposed by law looking to the security of the public or the efficiency of the service. The insurance companies for a long time followed—rather than led—the electric-light companies, and even to-day it is not believed that the American underwriters have any special regulations governing the installation of the electric light on board of ships.

All of the new ships have been provided for either in the contracts with the builders or by special appropriation, and the Navy Department is introducing this benefit, so important to the efficiency, health, and comfort of all, into such of the old ships as promise a life-time sufficient to justify the expenditure and a limited appropriation will permit. During the year the installations of the *Yorktown* and *Charleston* have been completed and the *Baltimore* and *Pensacola* well advanced, the work on the latter ship being done from the current appropriation of the Bureau of Navigation, while the others come under the appropriations in lump for the new ships. The contracts for these installations were made with the Edison Company, which likewise has the contracts for the *Philadelphia*, *San Francisco*, *Concord* and *Bennington*. The last two, with the *Yorktown*, are supplied with two generating sets, duplicates, while the *Pensacola* has but one, and the *Baltimore*, *Philadelphia*, *Charleston* and *San Francisco* are to have three each, all of the same pattern.

Congress has also appropriated for electric-light installations for the *Petrel*, *Vesuvius*, *Puritan*, *Monadnock*, *Miantonomoh*, *Terror* and *Amphitrite*, as well as for the receiving-ship *Vermont*. Those for the *Petrel*, *Vesuvius* and *Vermont* should be completed within the present year, and work on the remainder will be commenced as soon as the ships are in condition to receive them.

Much progress has been made in efficiency and security in the ships installed during the past year, the principal of the changes being the adoption of lower-speed machines directly coupled to the engine by means of a flexible coupling, thus avoiding the use of a belt, which is not suited to the conditions existing on shipboard (fig. 1). While the speed of the machines has been reduced to 400 turns, their output per pound of weight has been increased, and they have further been improved in the insulation of their coils and the reduction to a practicable minimum of the heating of the same. The engines used are two-cylinder instead of one-cylinder, as heretofore, giving a better balance and more perfect regulation.

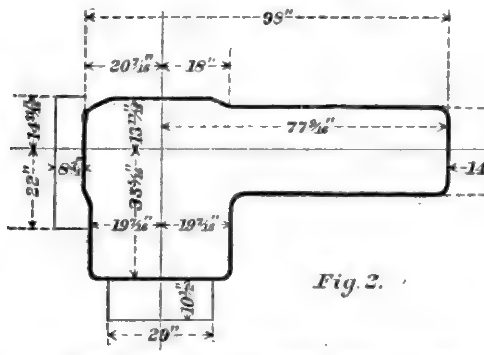


Fig. 2.

Floor space for 100-Ampere generating set.

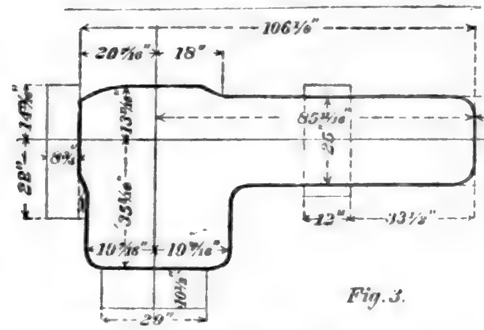
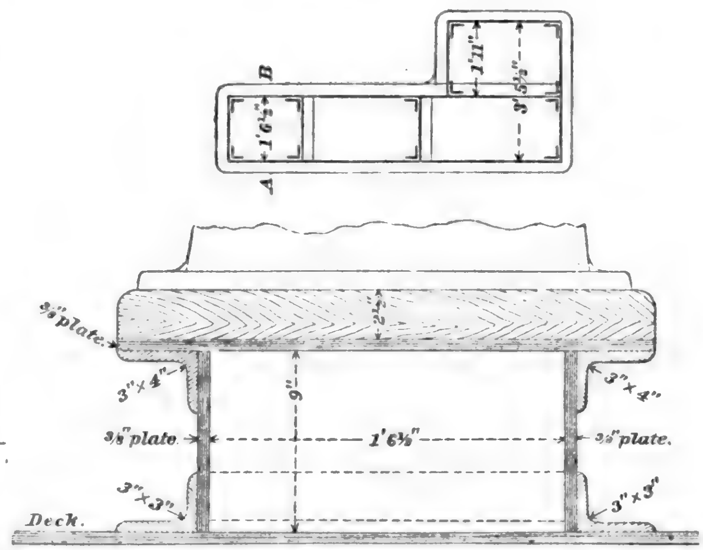


Fig. 3.

Floor space for 200-Ampere generating set.

Fig. 4



Section at A–B.
Foundation for 200-Ampere plant.

The improved character of the coverings of the conductors, the abolishing of soldered splices with their indifferent and constantly failing insulation, the substitution of substantial water-tight receptacles for portable plugs for the weak and inefficient ones formerly used, the improvement in the design of the water-tight switch and in the molding used, the introduction of incombustible bases for switches, receptacles and cut-outs, the supplanting of the wooden switch-board by one of incombustible material, and the installation of fixtures of excellent quality and suitable design, have all helped to render the system more complete by the elimination of faults either foreseen or already developed by experience.

A higher degree of insulation of the conductors when installed is demanded and obtained, and this can only be brought about by the use of good materials and superior workmanship in doing the wiring. The security from fire and the uninterrupted supply of the current depend upon this work, which is the most expensive part of the installation, and requires a considerable time for its performance. The dynamos and engines may be changed in a moment when worn out, or when, from the advance made in the production of generating sets, it may be deemed wise to replace them; but the wiring as a whole, once properly put in, should never require renewal. It is to an appreciation of these facts that is due the improvement made in its character, until the performance now generally accords with the requirements.

In describing briefly the character of our installations, the dynamo-room comes first—its location, the arrangement of its contents, and its ventilation; then, following the circuits from the switch-board, the manner in which they are run, the devices employed, and the different sorts of fixtures assigned to fill various offices, will be observed.

The location of the dynamo-room should be made with a view to the security of the machines during time of action and to its close proximity to the steam supply; the importance of the first being apparent, while the second requires but little reflection to appreciate the advantages of dry steam and the absence of the disadvantages attendant upon the conducting of large steam pipes to a considerable distance, and through the holds and fire-rooms of a ship. The space immediately forward of the forward fire-room satisfies the conditions best. Here enough floor space should be assigned, leaving sufficient head-room to afford opportunity for efficient attendance.

The spaces required for generating sets composed of Armington & Sims 7 × 5-in. double engines and Edison compound-wound multipolar dynamos, as installed in the *Yorktown* and in the *Baltimore*, are indicated in figs. 2 and 3, the heavy lines showing the outside dimensions of the bed-plates, the additional space in the direction of the length of the armature allowing for its withdrawal, and the laps over the engine end of the plates allowing for the cylinders and fly-wheel.

The bed-plates are set upon light steel foundations, built up 9 in. above the deck, and having on top of the steel cover a 2½-in. white pine floor, which, with a coaming around all sides, is covered with sheet lead to receive such part of the drip as may escape from the oil-way running around the bed-plate. Each plate is securely bolted through its flange and the flange of the foundation. A foundation for an Armington & Sims 7 × 5-in. engine and 200-ampère Edison multipolar dynamo is shown in the sketch with dimensions (fig. 4) This brings the commutators to a convenient height for the adjustment of the brushes.

A comparison of the space occupied and the weights of each of the two sets installed would be extremely unfair to that of 100 ampères, since its engine is, owing to an exigency, of exactly the same size as that used with the 200-ampère machines.

Comparing the weights of the dynamos, 1,841 lbs. and 3,370 lbs., with their outputs shows even then a slight difference in favor of the 200-ampère machine, which might be expected, it giving 4.75 watts per pound to 4.34 watts per pound of the 100-ampère machine.

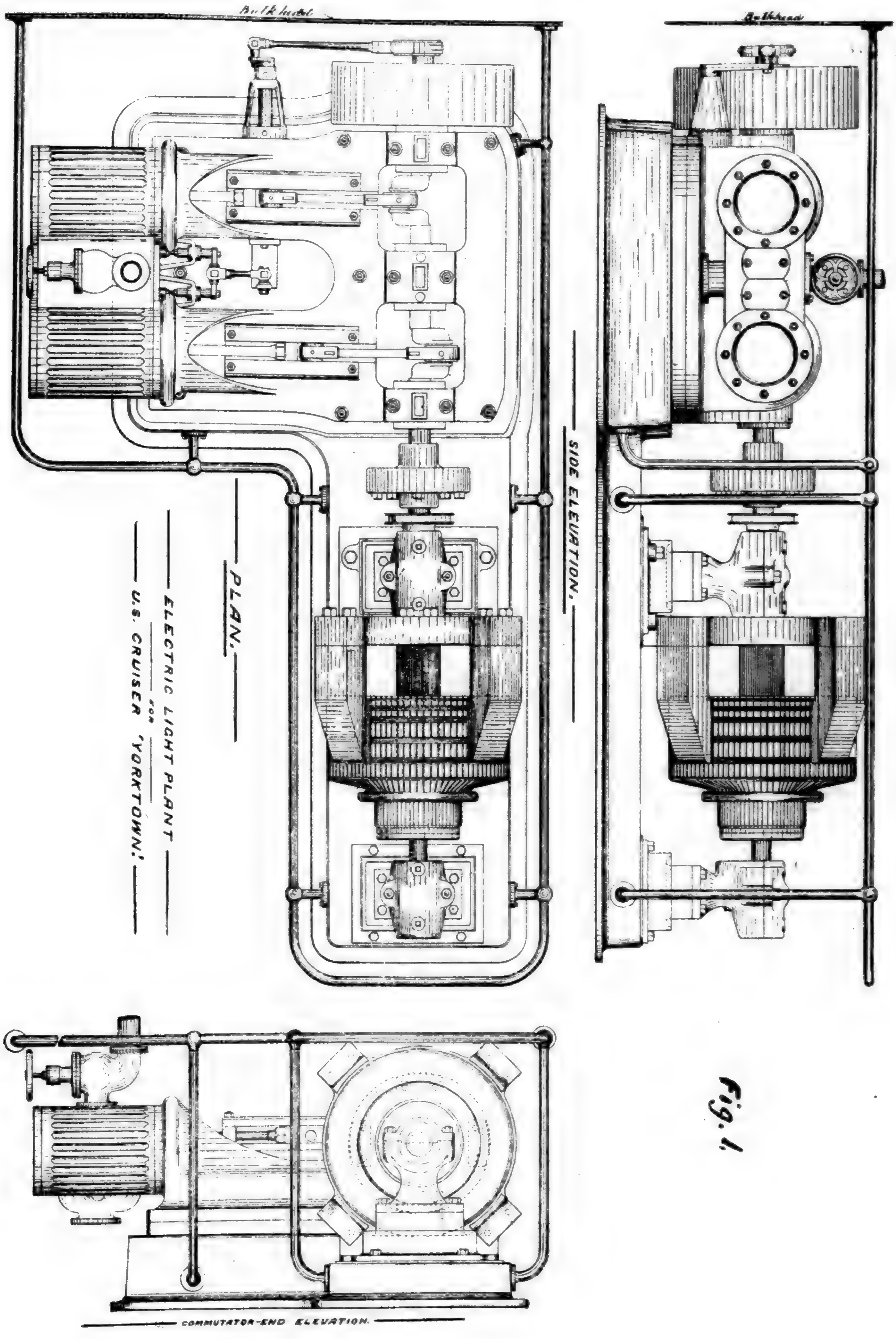

Bulkhead
Bulkhead
PLAN.
SIDE ELEVATION.
ELECTRIC LIGHT PLANT
FOR
U.S. CRUISER 'YORKTOWN.'
COMMUTATOR-END ELEVATION.

Fig. 1.

In addition to the spaces required for setting and operating the several generating sets, sufficient room must be allowed for the switch-board, which if practicable should be arranged so that a person may pass behind it, and having a shelf in front carrying the meters, and with the regulator boxes conveniently placed beneath the shelf; if practicable the steam separator and automatic trap should be located in the dynamo-room, and space should further be allowed for oil and waste tanks, and a suitable locker for tools. Preferably the switch-board should be as near as practicable to the commutator ends of the machines. It should be of such dimensions as may be required, and conform in shape to the space assigned it. Every part of it is made of incombustible materials, the board being of slate, the cut-out blocks of porcelain, and the switches being entirely of porcelain and metal.

The wiring of a ship is controlled by the considerations of the reduction to a minimum of the fall in electro-motive force, the probability of a break in a circuit, and danger from fire; there are other considerations, but these are the most important. The first ships installed were wired in the same manner as were houses, and since it is now an admitted fact that the work then done in the latter was hopelessly bad, it can easily be understood that on shipboard, with salt water penetrating nearly everywhere, it required constant attention to keep the lights in operation.

The lights having been assigned, and the sections laid out so as best to carry on the ship's duties and conform to the established routine usages of the service, the sections when brought to the switch-board are arranged, as near as may be practicable, so that the total work to be performed may be halved and each half may be fed separately by its own machine; or, if one machine will suffice to perform the duty at any moment, by means of switches any one of the machines may feed into all of the sections. Each section is controlled by a double pole switch and protected by a double pole cut-out.

A ground detector is attached to each half of the switch-board, a difference in the intensity of the lamps indicating a leak.

Every ship is provided with a testing set for measuring insulation resistances, but this requires the ship to be steady to operate it at all satisfactorily, so that ordinarily at sea no measurements could be taken, and reliance would be placed upon the ground-detector. The volt and ampère meters are made by Siemens, of London; the specifications requiring that they shall contain no permanent magnets nor depend upon the action of gravity. The regulator boxes are made of slate slabs carrying the coils, with brass standards at the corners. A tachometer is belted to the shaft of each armature, and it is proposed also to install a positive motion engine counter, in the readings of which there can be no mistake. A steam gauge and a vacuum or back-pressure gauge are likewise put in. By means of these various instruments, meters, indicators, gauges, ground detectors, etc., the attendant may intelligently carry on his work and not be compelled to guess at the cause of such difficulties as may occur, and with the natural consequences in such cases.

The steam supply is usually by a branch from the pipe supplying the other auxiliaries of the ship. It should have a reducing valve located at a sufficient distance from the engines to allow a steam space in the pipe and separator equal to at least five times the volume of steam used at a stroke by the engines getting steam through the valve. Trouble has been experienced with these valves, but not since they have been put in in this manner. The separator should be placed as near as practicable to the first branch taking steam from the pipe. At each branch of both steam and exhaust pipes a stop-valve is placed for convenience in making repairs. Into the drain from the trap should be carried the drips from the cylinders, and a drain from above the engine stop-valve; also, if the exhaust piping is carried up, it too should be arranged to be drained before starting up.

The dynamo-room, being below the protective deck and without any natural ventilation, should be thoroughly well ventilated artificially, as well as for the good performance of the machines as for the health of the attendants, and for this purpose it is supplied with independent conduits for the exhaust and supply of air and a fan and electric motor, those on the *Yorktown* being connected by a belt. While this latter performs in a fairly satisfactory manner, yet the belt is unnecessary and the arrangement wasteful of space; hence, in the *Baltimore* and other ships it is proposed to wind the armature upon the shaft of the fan. Careful attention to the covering of all steam-piping, cylinders and valve chests aids in keeping down the temperature.

As before stated, the number of lights, with the location of each and the style of fixture to be employed, is determined from a consideration of the duties of the ship and the manner of carrying them on, which considerations also prevail in the arrangement of the lights into sections. It is furthermore desirable that a section main should not exceed in size a No. 6 B. W. G. wire or its equivalent, as a larger one soon becomes very difficult to work; also, where practicable, it is usual to put the lights on the opposite sides of a deck upon different sections, so as to reduce the probability of total darkness. The sections having been laid out, the sizes of the mains, which are the same throughout their length, are calculated according to the rule laid down in the specifications.

The offshoots except to groups are No. 16 B. W. G. The wire used has been of excellent quality, and is known in the trade as the Habirshaw wire. In a test of several wires for use on the *Chicago* its record was the best.

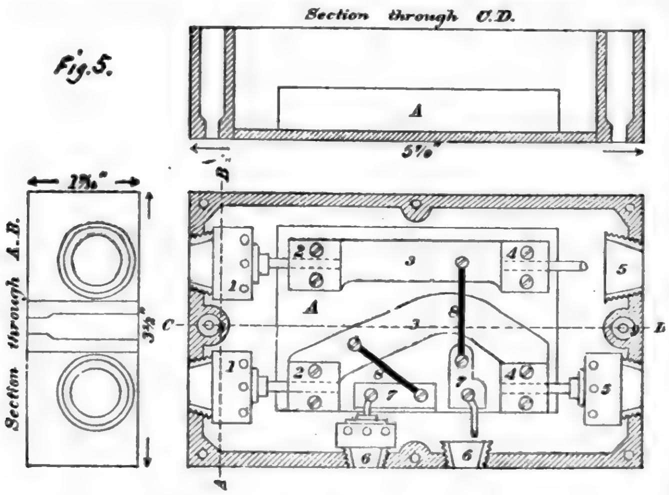
The mains and branches throughout the ship are of lead-covered wire, and are run in wooden molding. The molding is usually of white pine, but of polished hard wood where the wires cross such surfaces. The width of the rib separating the gutters allows of the secure fastening of the molding by means of brass screws without breaking through the sides, and thus sometimes grounding the lead covering of the wire. The thickness of the wood beneath the gutters allows the cutting away of sufficient to let in bolt heads and the like, and still leave half an inch of the wood. The gutters allow $\frac{1}{16}$ in. all around the conductors they are to take, which avoids bruising the lead in putting the wire in. After fitting, the molding is thoroughly covered with white lead paint. Molding should, where practicable, be coped instead of mitred. It has been the practice to cap over only such of the molding as was deemed necessary for the protection of the lead cover from mechanical injury, or where for neatness it was thought desirable, the remainder being uncapped and having the wires held in the gutters by fiber staples. It has been found that in driving these staples injury is sometimes done to the lead covering, and if found necessary to take down the molding, much of the lead cover would be destroyed. It has, therefore, been decided to cap all molding, as the capping offers a better protection, and with the disappearance in our work of underwriters' and other inferior insulations, it is not so important that every conductor should be in sight. The present insulation is good, and being further protected from water by the lead covering, it is reasonable to presume that the continuity of the conductors will not be broken by the attacks of salt water, and in consequence there is little danger to be apprehended. Other improvements in installations for the detection of leaks and for the measurement of resistances, give the officer in charge better opportunities than formerly to know the condition of the circuits. The objection to the use of capping is founded upon the same basis as the objection to lead-covered wire—*i.e.*, poor materials and poor workmanship.

Where conductors pass through beams, bulkheads and the like, the openings are lined with hard rubber tubing; in passing through decks and water-tight bulkheads, stuffing-boxes prevent the passage of water.

From a section-switch in the dynamo-room to the point where a branch is to be taken off for a light, unbroken lengths of wire are run; a junction-box (fig. 5) is here introduced, the wires from the switch-board entering through the stuffing-boxes 1 1, and being firmly bound beneath the caps 2 2 by means of screws. The junction strips 3 3 have also binding clamps 4 4 at the opposite ends, from which point the mains continue on, issuing through the stuffing-boxes 5 5, and continuing unbroken as before to the next point where a branch is to be run, where another junction-box is introduced. The branch wires enter by the stuffing-

boxes 6 6 and are taken to the binding posts 7 7. Between these posts and the pieces 3 3 are placed the fuses 8 8. Fuses are required to be at least $1\frac{1}{4}$ in. long, and are introduced at every change in the size of a conductor. All of the metal in the box in circuit is carried upon the block *A*, which may be of porcelain or other suitable incombustible material. The wells 9 9 take the screws which fasten the box in its place; these and the stuffing-boxes are put inside the junction-box merely to reduce the work of fitting the latter in place. The cover of the box is lined with rubber

Fig. 5.



cloth, which, besides packing the edges of the box, packs the screw wells also. The branch wires are carried to the point at which the light is to be placed, sufficient end being left to wire the fixture, thus avoiding a splice. In order to carry two No. 16 wires into a socket it is necessary to have the entrance in the base considerably enlarged.

All fixtures having keyless sockets, except the special wire-guard fixtures, have switches which may be water-tight or not, depending upon the location. The one-light switches are single pole, the parts in circuit being carried upon a block of similar material to that used in the junction-box; the water-tight switches being rendered so by inclosing the block carrying the switch in a water-tight bronze box, the wire entering and issuing through stuffing-boxes, the switch being operated by a key through the cover of the box, the stem of the key having a stuffing-box properly packed.

The water-tight receptacle for portable plugs consists of a bronze box having in the bottom a porcelain block carrying the necessary fittings for a wedge-shaped plug, the wires passing out through stuffing-boxes. The cover is hinged and closed by a catch, the inside of the cover being lined with rubber cloth to pack the edges, and the portable cord being wrapped so as to pack itself as it lies in a recess between the cover and the side of the box.

The switches and receptacles not water-tight are not peculiar to the service, so need not be described; but the growing and almost general use in this country of incombustible materials only, in switches, plug receptacles, cut-outs, regulator boxes, and switch-boards, and the possibility of obtaining such articles in the market, must be attributed to the requirements of the Navy Department in the installations put in under its direction.

Not only is it required that the circuits shall have a high insulation resistance, but the lead cover of the conductors, the junction, switch and receptacle boxes, and fixtures must all have half an inch of wood, at least, between them and outside metallic contact.

The fixtures have been much improved during the past year, more particularly in strength and finish. The special wire-guard fixture is the one generally employed, being adapted for fastening upon vertical surfaces. The board is made 2 in. thick to allow for cutting out at the back to let in bolt-heads and the like. The reflector is a corrugated-glass mirror; the lamp is inclosed in a steam-tight globe, the cover of which is supported by a goose-neck soldered into the switch-box. The branch wires enter the switch-box through stuffing-boxes, the lead cover being stripped after it enters the packing; a special quality of fixture wire carries the current from the switch to the socket. The switch is of the same sort as that already described.

The coal-bunker fixture resembles the last, but differs in having its switch located at a convenient point outside the bunker and having a larger and heavier guard with smaller meshes. The branch wires pass directly into the socket through stuffing-boxes in the cover to the steam-tight globe, the lead as in all other cases being stripped in the packing.

For lights upon the ceiling generally, the ordinary steam-tight globe fixture is employed, the branch wires passing through stuffing-boxes in the cover of the globe. At the water glasses in the fire-rooms and where necessary these fixtures are protected by a light metal guard or cage.

The state-room and office fixtures are supplied with a cord of sufficient length to permit their use in any part of the room.

The portables supplied for use in holes, boilers, double bottoms and similar places are provided with enough cord for the purpose, and are light and not easily injured.

Cabin and ward-room countries are fitted with electroliers or ceiling fixtures, the kind depending somewhat upon the height of the ceiling.

The running lanterns contain two 16 candle-power lamps supported from the top of the lantern, which is made thoroughly water-tight, the flexible cords passing out through stuffing-boxes, each plug going to its own receptacle. The lens heretofore employed is still used, the lamps being placed as advantageously as practicable and having a reflector behind them.

Other special fixtures are sometimes used as well as the ordinary bracket, pendant, etc., such as are installed on shore.

No satisfactory finish for fixtures has yet been obtained, everything yielding to the attacks of salt air and salt water. Nickel has been tried several times, but in each instance with very unsatisfactory results. At present bronze is used without any coloring, except in certain of the fixtures in cabins and ward-rooms, which are treated with acid.

Trouble has been experienced with the insulating parts of sockets and the ratchet-wheel of the one-light switches; these parts were made of fiber and also of other materials of unknown composition and brief lifetime, and it has been found necessary to reject all of them, as they take up moisture, and upon drying become distorted or disintegrate. Lava will probably be used in their stead.

All lamps are of 80 volts, and require 4 watts to the candle-power. They are of 10, 16, 32 or 50 candle-power each. Having adopted lamps of these dimensions as standard, and having in view the adoption of a standard socket and standard fixtures, ships abroad will be enabled to transfer stores to each other, which has not heretofore been practicable.

The ships as now installed are liberally fitted out, and with intelligent supervision and attendance, and the absolute prohibition of meddling with any part of the circuits, lamps, etc., by those not authorized, there need be little trouble anticipated. The tendency of thoughtless persons is to waste in using light when not required. A lamp used unnecessarily is not only consuming its guaranteed life, but fuel is wasted. The cost of lamps is an important item, and while this method of illumination is expected to promote health and comfort among the ship's company, extravagance is apt to occur and should be guarded against. An old lamp, having lost a part of its power, may still be of service in store-rooms and other places where such a light would suffice. Care should be taken to clean daily the lamps, globes and shades, if the best effect would be produced for the power expended.

Some trouble and inconvenience would be saved if the circuit be broken upon putting in or taking out of circuit a lamp or a portable plug. Neglect of this often causes the melting of the fuse, with the delay in consequence necessary for its renewal.

Junction and switch-boxes not properly closed are often found to be the cause of "bad" ground. Careful, steady men should be selected to operate the plant. Attention to

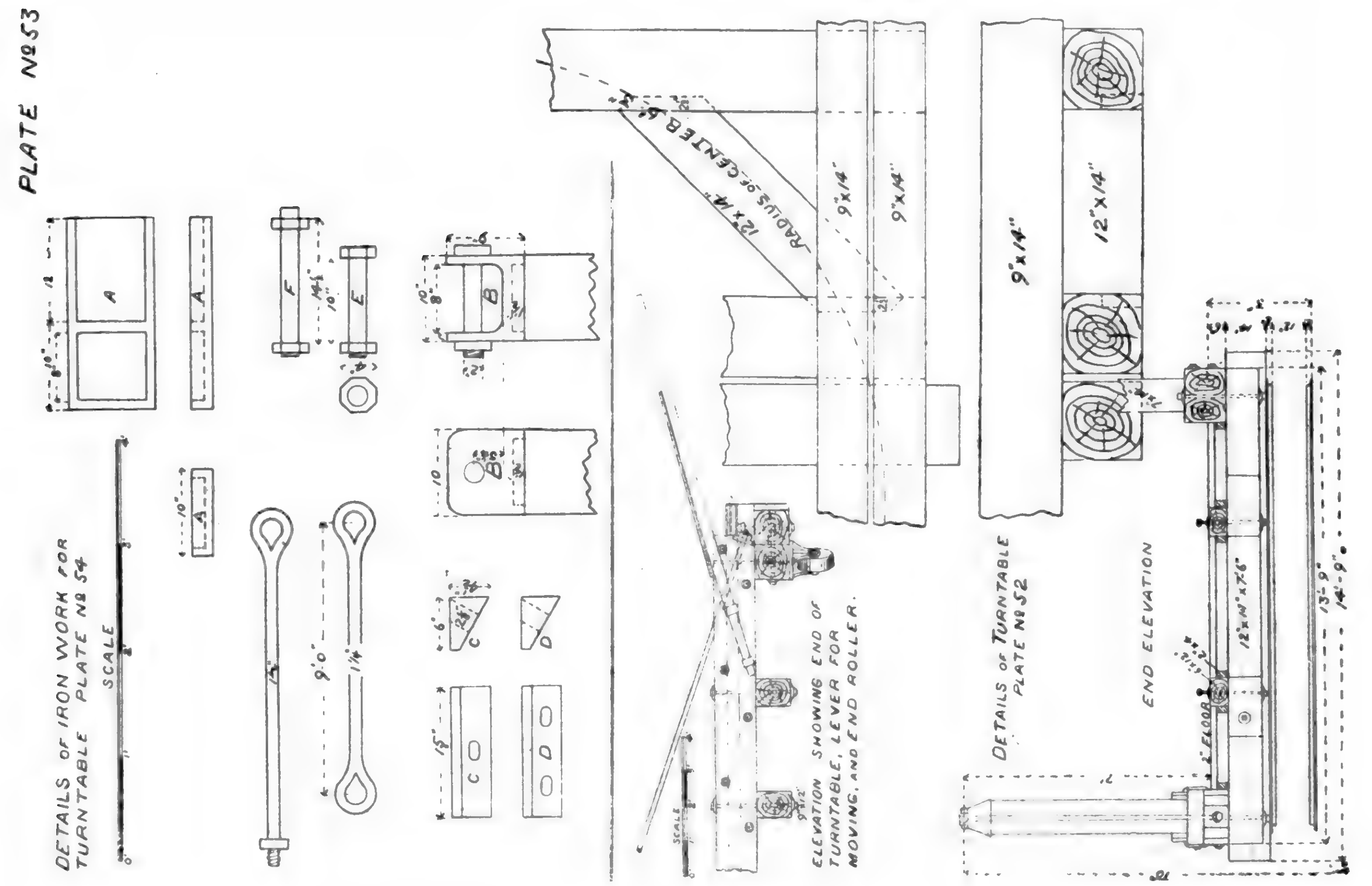
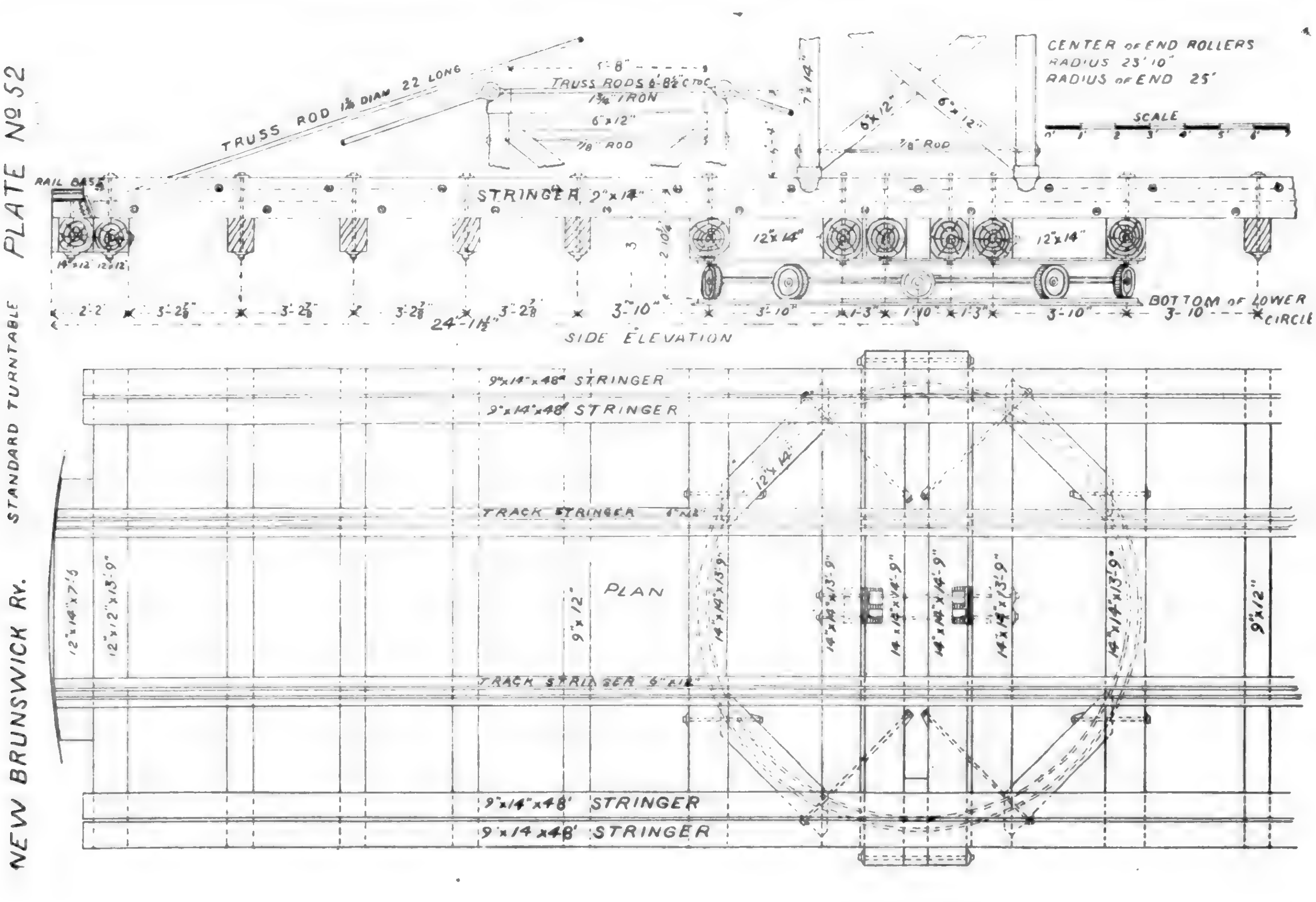


PLATE No 53
DETAILS OF IRON WORK FOR TURNTABLE PLATE No 54
SCALE
ELEVATION SHOWING END OF TURNTABLE, LEVER FOR MOVING, AND END ROLLER.
DETAILS OF TURNTABLE PLATE No 52
END ELEVATION
RADIUS OF CENTER
9"x14"
12"x14"


NEW BRUNSWICK RY. STANDARD TURNTABLE PLATE No 52
TRUSS ROD 1½ DIAM 22 LONG
TRUSS RODS 6'-8½ C TO C
1⅛" IRON
6"x12"
7/8" ROD
STRINGER 9"x14"
CENTER OF END ROLLERS RADIUS 23'-10"
RADIUS OF END 25'
SCALE
BOTTOM OF LOWER CIRCLE
24'-11½"
SIDE ELEVATION
9"x14"x48' STRINGER
TRACK STRINGER
PLAN

seeming trifles will keep everything in order and diminish accidents, which in most cases are caused simply by neglect. Attendants who have had little experience are usually afraid of the machine, or they feel that they have acquired about all that is worth knowing; of the two, the uncertain man is to be preferred, as he will in time acquire confidence; but the latter will often cause trouble by meddlesome acts, the consequences of which he is not wise enough to foresee. A favorite place for the operations of these is the commutator, which, if they are not checked, would soon be worn away by frequent dressing down with the file. This should be prohibited by the officer in charge of the machines, who should allow neither file nor sandpaper to touch the commutators except by his directions. The expenditure in brushes should be watched, as these are likely to be worn away more under the file than on the machines. With everything in working order and an intelligent set of attendants it should not require more than 15 minutes per day of the time of the officer having charge of the installation.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page* 425.)

CHAPTER XIV.

TURN-TABLES.

PLATE 52 shows plan, elevation, and some details of the Standard Turn-table of the New Brunswick Railroad.

The distinctive feature of this form of table is the large center-bearing given it by means of the inner circle and rollers, and in this also consists the principal defect in the table, particularly at the present time. If, when the locomotive is run upon the table, great care is used to exactly balance it over the center, so that an equal weight comes upon all the center wheels, the table works in a most satisfactory manner. But to effect this equality of bearing requires much care and a nicety in the handling of the locomotive that consumes too much time. When the locomotive is not balanced, however, most of the weight being thrown upon the wheels on one side, causes those wheels to bind and thus interferes greatly in the manipulation of the table. As the wheels are carried toward the center, this weight has also a tendency to force the wheels out and often to such an extent as to break them, and result in an accident. With the comparatively light locomotives used in years passed this defect was not so noticeable, and owing to the simplicity of construction this style of table has been very generally used until within the last few years.

The form of trussing used, by means of which this table is rendered stiff, is exceedingly simple, and where large timber can be easily procured for the chord pieces (as is the case on the New Brunswick Railroad) is cheap. But owing to the lack of support between the ends and the inner circle, exceedingly heavy chord timbers are necessary in order to give the requisite stiffness. The trussing being only 6 ft. 4 in. high renders all lateral bracing impossible. This, however, is a matter of secondary importance in a turn-table, as owing to the low speed of the locomotive very little shock is felt, and when care is taken in the framing sufficient lateral stiffness is obtained.

Plate 53 shows the end elevation and detail of the center framing of the turn-table shown in Plate 54.

Plate No. 54 shows plans and elevations of the Standard Turn-table used upon the Chicago, Rock Island & Pacific Railroad, the details of the iron-work being shown in Plate 53. In this style of turn-table are remedied two of the defects that exist in the turn-table shown in Plate 52.

1. The inner circle of rollers is done away with and all the weight possible is thrown upon this center bearing. This center bearing consists simply of a chilled pivot that turns on a washer in the bottom of a socket in the lower casting. This socket is kept filled with oil and the washer is replaced whenever it becomes so much worn as to throw too much weight upon the end rollers.

This arrangement obviates entirely the objections arising from an inner circle of rollers, and makes it of less importance that the locomotive should be perfectly balanced on the center.

2. The chord pieces are supported not only at the ends upon the rollers and at the center, but at a point midway between the center and ends by means of a tie rod. This point of the chords being subjected to the greatest strain, must either be well supported or the chord must be of sufficient size to be stiff enough in itself, as is the case in the turn-table, Plate 52. In this style of table the gallows-frame is of sufficient height to allow of lateral bracing.

In many cases the gallows-frame is carried to a sufficient height to do away with the long, inclined truss at each side. To do this, however, requires longer timber, and some form of double portal bracing should be used. Some form of these iron and wood turn-tables will always be used upon roads where wood is cheap and the table not in constant use. At all terminal stations, however, or stations where there are large repair shops, some form of iron turn-table is in every way preferable. The turn-table shown in Plate 54, as constructed by the Chicago, Rock Island & Pacific Railroad, costs about $700, while the iron turn-table, as built by Sellers, of Philadelphia, costs in place from $1,000 to $1,200.

The following are the bills of material for the two turn-tables shown in the plates:

No. 31. Bill of Material for Turn-Table. Plate 52.

Wood.

4 pieces 9 in. × 14 in. × 48 ft.
8 pieces 9 in. × 12 in. × 13 ft. 9 in.
2 pieces 12 in. × 12 in. × 13 ft. 9 in.
2 pieces 12 in. × 14 in. × 7 ft. 6 in.
4 pieces 14 in. × 14 in. × 13 ft. 9 in.
2 pieces 14 in. × 14 in. × 14 ft. 9 in.
4 pieces 12 in. × 14 in. × 10 ft.
4 pieces 7 in. × 14 in. × 5 ft. 3 in.
4 pieces 6 in. × 12 in. × 7 ft. 6 in.
2 pieces 6 in. × 12 in. × 5 ft. 8 in.
2 pieces 6 in. × 12 in. × 50 ft.
300 lin. ft. 2 in. × 4 in.
466 ft. B. M. 2 in. flooring.

Iron.

4 rods 1¾ in. × 22 ft. center of eye to end of rod. Rod to have 1⅝ in. eye at one end and nut and washer at the other; the ends to be upset for the thread.
2 rods 1⅜ in. × 6 ft. 8⅛ in. from center to center of eyes. Rod to have eyes at each end.
2 rods, ⅝ in. × 7 ft. head, nut and washers.
4 castings for foot of posts.
4 castings for top of posts.
2 castings for center bearings.
8 16-in. wheels for center.
4 rollers for ends.
20 bolts 1 in. × 28 in., head, nut and washers.
70 bolts ⅝ in. × 22 in., head, nut and washers.
12 bolts 1 in. × 30 in., head, nut and washers.
20 bolts ¾ in. × 20 in., head, nut and washers.
4 bolts 1 in. × 53 in., head, nut and washers.
4 bolts 1 in. × 24 in., head, nut and washers.
2 bolts 1 in. × 39 in., head, nut and washers.
4 bolts ¾ in. × 24 in., head, nut and washers.

No. 32. Bill of Material for Chicago, Rock Island & Pacific Turn-Table. Plates 53 and 54.

Wood.

8 pieces 7 in. × 14 in. × 26 ft. pine chords.
4 pieces 7 in. × 14 in. × 20 ft. pine chords.
6 pieces 8 in. × 16 in. × 18 ft. pine track stringers.
16 pieces 6 in. × 12 in. × 14 ft. 6 in. pine floor beams.
10 pieces 8 in. × 16 in. × 14 ft. 6 in. pine floor beams.
2 pieces 12 in. × 16 in. × 14 ft. 6 in. pine end floor beams.
3 pieces 12 in. × 14 in. × 10 ft. pine bolsters.
8 pieces 10 in. × 10 in. × 14 ft. pine gallows-frame.
8 pieces 5 in. × 8 in. × 10 ft. 6 in. pine gallows-frame braces.

Iron.

4 eye-bars 1⅜ in. × 17 ft. 6 in. from center of eye to end of rod (*H*).
8 eye-bars 1½ in. × 20 ft. 1½ in. from center of eye to end of rod (*H*).
14 eye-bars 1¾ in. × 9 ft. from center to center of eye (*G*).
2 rods 1 in. × 15 ft., with swivel and eye on each end.

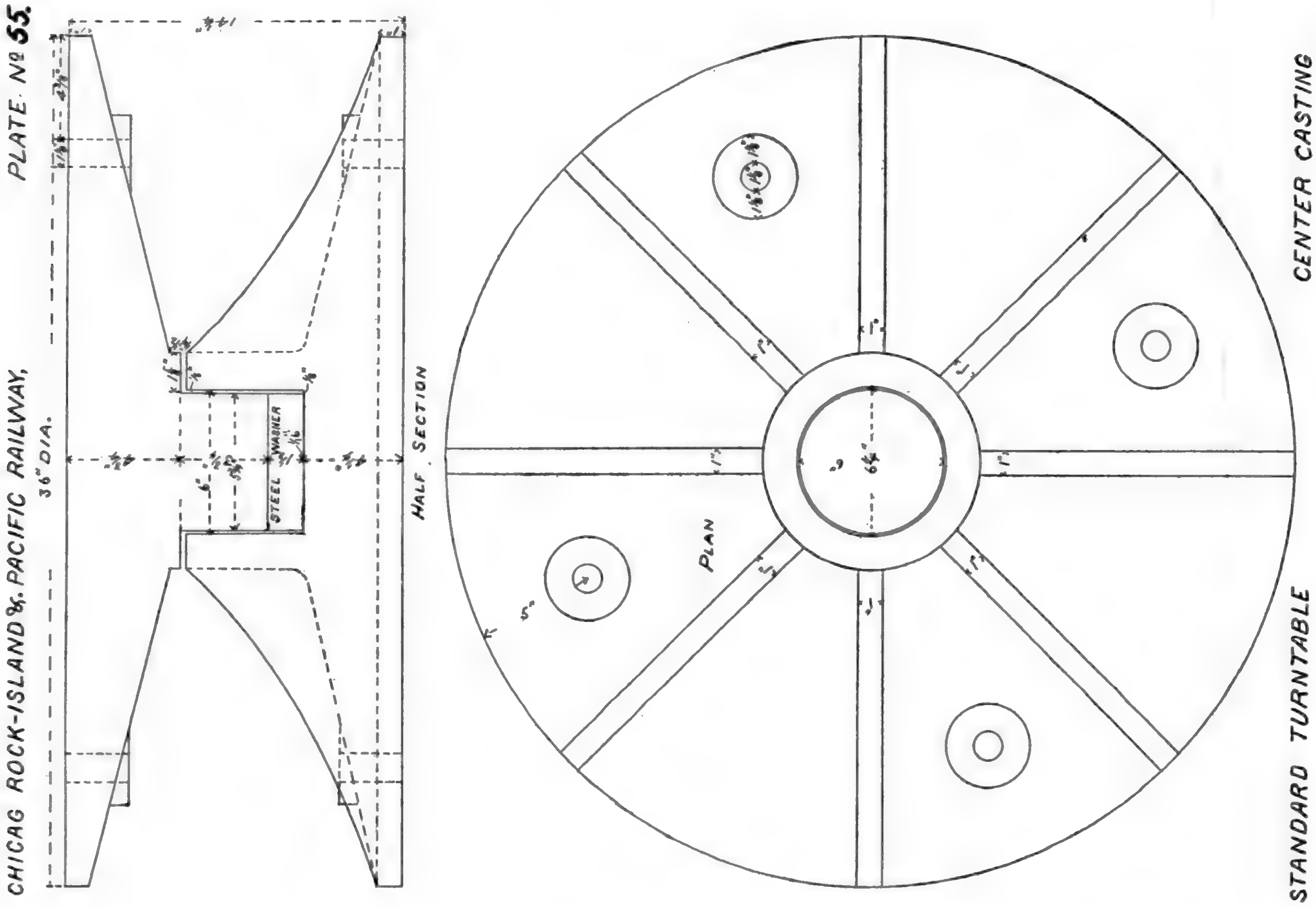
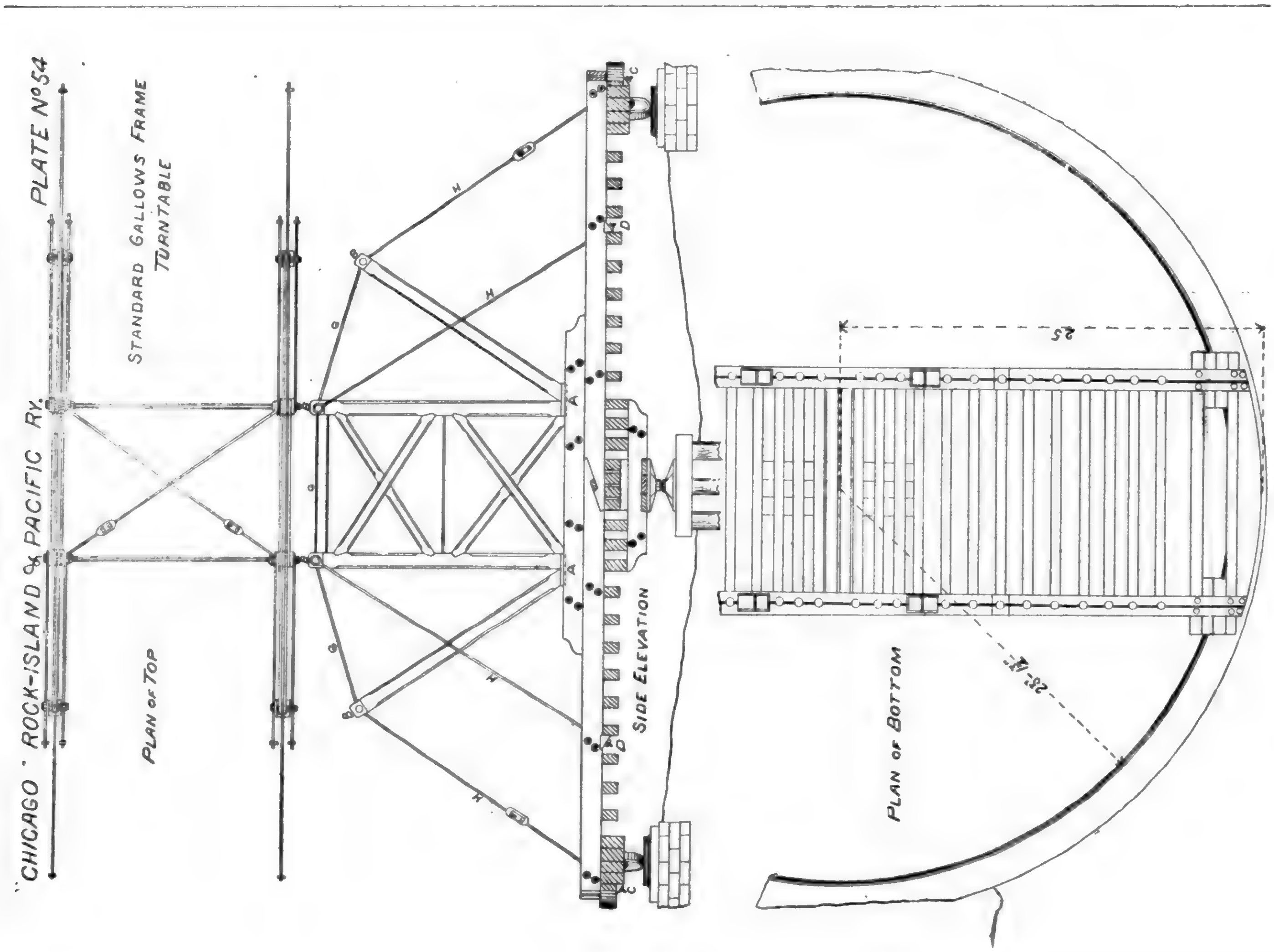


PLATE No 55.
CHICAG ROCK-ISLAND & PACIFIC RAILWAY,
36" DIA.
STEEL WASHER
HALF SECTION
PLAN
STANDARD TURNTABLE
CENTER CASTING


CHICAGO · ROCK-ISLAND & PACIFIC RY.
PLATE No 54
STANDARD GALLOWS FRAME TURNTABLE
PLAN OF TOP
SIDE ELEVATION
PLAN OF BOTTOM

3 truss rods for center timbers, 1½ × 15 ft.
4 castings as per detail *A*.
8 castings as per detail *B*.
4 castings as per detail *C*.
4 castings as per detail *D*.
4 2-in. pins as per detail *E*.
4 2-in. pins as per detail *F*.
2 center castings.
4 truck wheels and boxing.
32 bolts ¾ in. × 18 in.
4 bolts 1 in. × 10 ft. 1½ in.
20 bolts 1 in. × 46½ in.
8 bolts 1 in. × 42½ in.
4 bolts 1 in. × 35½ in.
16 bolts 1 in. × 32⅝ in.
32 bolts 1 in. × 28⅝ in.
168 1-in. cast washers.
64 ¾-in. cast washers.

The truss-rods for the center timbers are to be bent as follows: At points 1 ft. each side of the center bend the rods until their extremities are 14 ft. 6 in. apart, and are 22 in. from a straight line drawn through the original position of the rod.

This bill of material includes only the material needed in the construction of the table proper, and does not include rails, guard-rails, material for building the pit, etc.

CHAPTER XV.

PILES AND PILE-DRIVING.

Among the first points to be considered in driving piles is the thickness and character of the different strata through which they have to be driven; also the depth below the surface at which strata of sufficient firmness to support them can be reached. These are the principal points that have to be taken into account where piles are driven for the purpose of supporting any superincumbent weight.

There are two methods of forcing piles into the ground. One, which has been used thousands of years, and until very recently was the only method, is that of forcing them into the ground by means of blows or impact of some kind. The second method, which is of comparatively modern date, and can only be applied economically under particular circumstances, is that of *screwing* them into the ground, the point of the pile being furnished with a large metal screw point, and a rotary motion given to it by means of levers or other suitable mechanism.

The object of the use of piles is to replace loose, unstable ground with something that is firm, solid, and capable of bearing with safety all the weight that of necessity comes upon it. Piles are used either to support a superincumbent weight, as when they are driven to form the foundations of buildings, piers, retaining walls, etc.; or they are used in the form of sheet-piling, to support banks of earth or loose material, something in the form of a retaining wall. They are frequently used as sheet-piling to support the sides of excavations for foundations of buildings, piers, or abutments, or in excavating deep trenches through material which is not sufficiently firm to hold itself vertical during the time of excavation. For the first object—that is, serving as the foundation for a building or piece of masonry—it is very necessary that the piles should penetrate to solid ground or solid rock, if possible. Very often there is not enough attention paid to this fact. One reason for this lack of attention is, that as the pile is driven lower and lower, at last a point is reached where it sinks very little after each blow of the hammer, and it is very apt to be considered that when the pile has reached this point it has sufficient solidity to bear the required weight. But one great cause of the slight penetration of the pile after it has been driven to a certain extent is the increased amount of friction between its sides and the material through which it passes. The amount of this friction depends to a certain extent upon the class of material. In the case of sand, it is almost as impossible to drive a pile any distance through it as it is through solid rock, and in gravel the difficulty increases the finer it gets. That is, starting with sand, the difficulty experienced in driving piles is almost inversely as the size of the particles of which the material is composed.

Another thing to be remembered in driving piles to a secure foundation, is the difference between the ultimate load that is to rest on them and the quick blow of impact which is given them in driving. It is an established fact in mechanics, and also in practice, that a permanent load resting upon a pile will eventually have nearly ten times as much effect upon it as that same load brought quickly upon it and as quickly removed. So that although the pile may penetrate a very little distance from each blow of the hammer, and the weight of the hammer multiplied by the velocity which it has at the time of impact may give a blow that in pounds is much greater than any weight that will come on it from its permanent load, still, after the permanent load has been resting some time upon the pile we very often see examples where it begins to yield, the foundation sinks, and as in very few cases it sinks with regularity over its whole surface, the result is that, if the superincumbent load consists of masonry, one part sinks while the other does not, and there is a crack or fracture in the masonry. There have been cases where none of the piles in a foundation were driven sufficiently far, so that when the masonry was built upon them, the whole foundation sank with perfect uniformity. This, in itself, was not of much consequence, particularly if the structure resting upon the masonry was not an arch. In case it was a masonry arch, it became broken. Wherever there is any doubt about the foundation, and where there is any probability that it will yield to the weight of the piers upon it, it is always better to span the opening by means of a girder rather than a masonry arch, for the reason that the sinking of one end of a girder, up to a certain amount, is of comparatively little consequence. In case the opening is spanned by a metal arch, among many other advantages of using what is called a hinged joint is the one that, if the foundation yields slightly, it does not in any way affect the arch, as owing to the hinge the arch can accommodate itself to the new circumstances.

Where piling is to be done to any great extent, and there is great doubt as to the distance the piles will have to be driven in order to encounter a firm foundation, the material should be tested, either by boring until solid material is encountered, or by driving what are called test piles. But even where the greatest care has been used, there have been numerous examples where the character of the ground changed so much within a comparatively short distance that these borings and test piles were of absolutely no use in the subsequent work.

In regard to the timber for piles, hemlock, pine and spruce constitute the principal timber that is used in this country. Of course the piles should be as straight as possible, and where they are to be used under water should be stripped of their bark and used in the green state. The great danger from driving piles is the splitting of the pile, and the necessity of extracting it or sawing it off and driving another one near it. Any one who has had any experience in pile-driving will appreciate at once the great difficulty of pulling piles. It is almost impossible in ordinary work, but where the work is carried on in tide-water, a very convenient way is to lash the pile very tightly to two timbers at low water that rest upon scows, and when the tide rises the force of the water itself will very often raise the pile.

Where piles are used entirely under water, so that they are kept wet all the time, they will last almost any length of time, provided they are not subject to the attacks of the *teredo navalis*, or pile-worm. This pest is only encountered in salt water, and in greater quantities the nearer we approach the equator. It works between high and low water, and in a very short time cuts the piles off. A great many different remedies have been tried to withstand the attacks of this worm. The creosoting process is probably the most successful of any of the chemical treatments to which wood has been subjected for this purpose. A very good method, although expensive, is to sheathe the piles entirely with copper, which, of course, withstands the sea-water and the attack of the *teredo*. This trouble of using wooden piles in salt water has led to the very extensive use of iron piles. This subject of iron piles will be taken up later.

Where the timber is too large to be used in one piece,

and where the best of timber is necessary, only the heart should be used.

The piles that we have just described—that is, those for the support of a superimposed load—are what are called bearing piles, while sheet-piles, as we have said, are for the holding up of banks of earth, during excavation or permanently. Piles are also driven in some cases in order to consolidate ground which otherwise is too loose and unstable to bear a weight. In this case, the piles are usually short, and driven very closely together, beginning with the outside circle and driving toward the center. This method, however, has gone very much into disuse of late years, owing to the fact that most engineers prefer to use concrete in such ground rather than to consolidate it by means of piles.

Fender piles are simply what their name would indicate —that is, piles driven in front of large masonry walls or other important works, in order to protect them from sudden blows.

At different times piles with screw points have been tried, the screw points having been made of cast iron and about 2 ft. in length. They never have been particularly successful, are very expensive, and should never be used except where the material through which the pile is driven consists of sand, or where timber is so expensive that there is an actual gain by the use of cast-iron points.

CHAPTER XVI.

RAMS AND HAMMERS.

The ordinary method of driving piles is by dropping a weight, either a ram, a hammer, or a monkey, upon them. This weight in some cases is made of timber loaded with iron, but usually of cast iron. It is raised either by means of hand-power or steam, usually by steam. The exact effect of these blows upon the top of the pile is not known. The effect from experiment is very irregular. The actual force with which the hammer strikes the pile can be easily calculated from the formula for accelerated velocity and the law of falling bodies. The body will fall through a space, S, in the time $\frac{\sqrt{S}}{g}$ where g equals $16\frac{1}{12}$ ft., or the space that a body falls in one second. The acquired velocity is directly proportional to the time of the fall, and the velocity at the end of the first second is $32\frac{1}{6}$ ft. Hence, falling through any space the velocity that will be acquired by a body will be $32\frac{1}{6}\ \frac{\sqrt{S}}{g}$. From this we have the velocity that the ram or hammer will have after having fallen any required distance. Then, to find the force with which that hammer will act upon the head of the pile, we have simply to multiply the weight of the hammer by this acquired velocity, and we have the number of pounds with which the hammer acts upon the head of the pile. We must remember that the velocity to be used in this case is not the velocity that the hammer had in the second before it reached the pile, but the velocity that it would have had in the next second if it had not been stopped by the pile.

From the above equation the accompanying table No. I. has been calculated, showing exactly the force of impact of a hammer weighing one ton falling through different distances.

In regard to the weight of the ram that should be used, opinions differ among engineers. A heavy ram or hammer with a very short blow is undoubtedly the best for many reasons; the only drawback to it is the increased amount of power necessary for raising the hammer. A light hammer with a long fall is very apt to split the pile, and by an examination of this table it can readily be seen that the effect of a blow does not in any way increase directly as the fall increases. Thus, a hammer falling 6 ft. gives a force of 20 tons, while a hammer falling 12 ft. only gives a force of impact of 28 tons. Thus, while we have doubled the distance through which we must move the hammer, we have only increased the working force from 20 to 28 tons.

The height of fall is also a question upon which there is great variation of opinion, but there is one thing that we must remember—that these rams or hammers in falling are not allowed to fall freely—that is, they are held in the leads of the pile-driver, and of course there is a certain amount of friction between the sides of the hammer and these leads; this friction is so great that there is absolutely nothing gained by making the leads over 40 ft.

TABLE I.

Fall of ram in feet	Time of descent in seconds.	Force in tons for a ram weighing one ton.	Fall of ram in feet.	Time of descent in seconds.	Force in tons for a ram weighing one ton.	Fall of ram in feet.	Time of descent in seconds.	Force in tons for a ram weighing one ton.
1	0.25	8.0	15	0.96	31.0	28	1 32	42.4
2	0.35	11.3	16	1.00	32.1	29	1.34	43.2
3	0.43	13.9	17	1.03	33.1	30	1.37	43.9
4	0.50	16.0	18	1.05	34.0	31	1.39	44.6
5	0.56	17.6	19	1.09	35.0	32	1.41	45 4
6	0.61	19.6	20	1.11	35.9	33	1.43	46.1
7	0.66	21.2	21	1.14	36.7	34	1.45	46.8
8	0.70	22.7	22	1.17	37.6	35	1 48	47.4
9	0.75	24.1	23	1.20	38.5	36	1.50	48.1
10	0.79	25.3	24	1.22	39.3	37	1.52	48.8
11	0.83	26.6	25	1.25	40.1	38	1.54	49.4
12	0.86	27.8	26	1.27	40.9	39	1.56	50.1
13	0.90	28.9	27	1.29	41.7	40	1.58	50.7
14	0.93	30.0						

The weight of the hammer should be proportional to the cross-section of the pile that is to be driven. Take a pile 10 or 14 in. in diameter, and the hammer should be from 1,000 to 1,700 lbs. in weight. The following equation will give approximately the weight of hammer for the most economical driving of the pile under the following circumstances:

F = fall in feet.
W = weight of the ram.
B = breadth of the pile in inches.
T = thickness of the pile in inches.
L = length of the pile in feet.
W_1 = weight of the pile in pounds.

We then have the following equation:

$$W = W_1\left(\frac{F \times W_1}{5\,B\,T\,L} - 1\right).$$

When the pile is square, the term $B\,T$ can be replaced by S^2.

The weight of the hammer and the distance through which it falls are not the only points to be considered in connection with the driving of piles. The rapidity with which the blows can be given is a very important point and must be considered. For instance, in material like sand or silt, at every blow of the hammer the pile is driven a certain distance, the material through which it is driven is disturbed to a certain extent, and if the blows are repeated with sufficient rapidity not to allow time between the blows for the material to settle back into place, there is comparatively very little friction between the sides of the pile and the material. The pile can be driven to a very great depth with little injury to itself, and the material settles back, afterward rendering it very firm; but if the interval between the blows is of such a length that the material has time to settle back into place after each blow that has been given, then, especially in sand mixed with water, it becomes almost as impossible to force the pile down as if it had been driven through solid rock. From this can be seen the great advantage of rapidity in the blows. This is what forms one of the greatest advantages in the use of the different steam-hammers, or steam pile-drivers, so called, that have recently come into such general use. A description of these pile-drivers will be taken up later.

In salt water, or where timber would be subjected to an attack of the *teredo*, cast-iron piles have been used with great success. There were strong objections made to their use in the first place, owing to the fact that it was

supposed that they would be corroded in a short time and thus rendered useless. Of course, years enough have not yet gone by to prove by the test of time that cast-iron piles will stand the corroding action of salt water, but according to the experiments that have been made, there is every probability to suppose that cast-iron piles will under ordinary circumstances last hundreds of years. It has been found that if they can be driven in such a way that the outside skin or casing of the casting is not broken, the action of the water is very much less than if this skin is fractured and the water allowed to get upon the interior part.

In regard to the supporting power of piles, this is a question which, if certain premises are allowed, can be thoroughly treated from a theoretical standpoint, and most accurate mathematical results arrived at. The only trouble is that no two piles have the same surrounding circumstances, or can be treated in exactly the same way, so that all the formulas that are given for the supporting power of the piles have to be used with caution, and in very many cases their results will not be borne out by actual experiment.

In regard to the following formulas, they must all be used with caution, owing to the fact that there is great variation in the material through which the pile is driven. The following formula is by Weisbach:

$$L = W\left(\frac{W}{W + W_1}\right) \times \frac{H}{D}.$$

In it W is the weight of the ram in tons, W_1 the weight of the pile in tons, H the height of the fall of the ram in feet, D the depth which the last stroke drives the pile.

The following formula is taken from Rankine, and shows the relation between the blow required to drive the pile to a given depth, and the greatest load that it will bear without sinking further, supposing it to be supported by a uniformly distributed friction against its sides. Let W be the weight of the ram, H the height from which it falls, D the depth through which the pile is driven by the last blow, P the greatest load it will bear without sinking further, S the sectional area of the pile, L its length, E its modulus of elasticity; then the energy of the blow is thus employed:

$$W \times H \frac{P^2 \times L}{4 P S}.$$

This is the portion employed in compressing the pile, and $P \times D$ multiplied in driving it.

From which P equals

$$\sqrt{\left(\frac{4 E S W H}{L} + \frac{4 E^2 S^2 D^2}{L^2}\right)} - \frac{2 E S D}{L}.$$

The piles are generally driven until P by this formula equals 2,000 or 3,000 lbs. to the square inch of sectional area, and as their working load is from 200 to 300 lbs., that gives a factor of safety of about 10.

It is very important that all the piles which are to bear a distributed load should be driven uniformly, so as to insure that each pile is supporting its proper share of this load, and it is necessary to have some data to adhere to in driving them.

The following very simple formula by Sanders probably gives as good results as any, where $W = \frac{R}{8} - \frac{F}{D}$ where W is the weight that can be safely placed on the pile, R the weight of the ram, F the fall of the ram in making the last blow, and D the distance the pile sinks with the blow.

Comparing these formulas, we find that Rankine and Weisbach give the supporting power of the pile about $5\frac{1}{2}$ times as much as Sanders, but as each of these authorities state that the safe working load should be from $\frac{1}{10}$ to $\frac{1}{4}$ of the amount given by their formulas, the result will come very near to that given by Sanders.

The accompanying table, No. II., gives the supporting power of piles, calculated by the aid of the various formulas:

The letters have the following signification:

W = the safe load on the pile in Sanders's formula and the theoretical load in Rankine's and Weisbach's.

F = the fall of the ram in making the last blow.

D = the distance the pile sinks with the last blow.

R = the weight of the ram, which is taken constant and equal to one ton.

L = the total length of the pile.

P = the weight of the pile.

S = the sectional area of the pile, which is taken at 0.7 of a foot.

E = the modulus of elasticity, with a value of 331,100 inch-pounds.

TABLE II.

No. of Pile.	Depth in Ground.	Total length of Pile (L).	Value of $P = L \times 0.22$.	Value of D.	Value of F.	Sanders's.	Rankine's.	Weisbach's.
	Feet.	Feet.	Tons.	Feet.	Feet.	Value	(W) in	tons.
1	15.00	20.00	0.440	0.0573	10.58	23.09	111.68	128.22
2	13.00	18.00	0.396	0.1094	11.83	13.52	87.03	77.75
3	12.00	17.00	0.374	0.0833	10.00	15.00	91.41	87.72
4	12.50	17.50	0.385	0.0833	10.50	15.75	94.52	91.34
5	13.25	24.75	0.544	0.0313	10.00	40.00	122.04	206.93
6	13.00	24.75	0.544	0.0677	11.50	21.23	103.79	109.53
7	13.67	25.17	0.544	0.0885	10.00	14.12	81.37	72.71
8	16.00	27.50	0.605	0.0573	10.00	21.82	97.69	109.31
9	15.58	26.33	0.579	0.0625	10.00	20.00	95.52	101.33
10	16.00	27.00	0.594	0.0625	10.00	20.00	94.82	100.38
11	16.75	27.50	0.605	0.0625	10.00	20.00	94.33	99.69
12	17.50	28.25	0.622	0.0469	10.00	26.67	103.97	131.45
13	14.67	24.17	0.532	0.0729	10.00	17.14	91.05	89.42
14	13.50	23.50	0.517	0.0833	10.00	15.00	85.47	79.14
15	17.67	26.17	0.576	0.0678	10.00	18.46	92.31	93.71
16	17.25	25.75	0.567	0.0573	8.00	17.45	85.06	89.11
17	18.25	23.73	0.522	0.0781	10.00	16.00	88.28	84.09
18	18.67	24.17	0.532	0.0833	10.00	15.00	84.93	78.33
19	14.92	20.42	0.449	0.0833	10.00	15.00	88.16	82.82
20	16.25	21.75	0.479	0.0729	10.00	17.14	93.45	92.72

Where piles are to be driven any distance, and through material that presents any particular resistance, the head of the piles should always be banded by means of a heavy wrought iron ring, this ring being made of about $\frac{3}{4}$-in. iron 3 in. broad. If, during the process of driving, the head becomes bruised so as to form a sort of a cushion, this bruised portion of the pile should be instantly sawed away and the head rebanded, as as much as four-fifths of the effective force of the ram soon becomes absorbed in this semi-elastic cushion.

In regard to shoeing piles, unless the material presents a great deal of resistance, it is not absolutely necessary to shoe them. They should be pointed to a certain extent, and, when necessary, shod by means of wrought-iron or cast-iron shoes. The simpler the form of the shoe, of course, the less expensive the work. Any treatise on pile-driving shows the different forms of shoeing that are used.

In driving piles in deep water, or under circumstances where it is necessary for the pile-driver to be placed a great distance above where the ultimate top of the pile is to come, in order to save timber the piles are only cut the required length, and when the top comes below the bottom of the leads, a dolly or follower is used to drive them farther. This is simply a piece of timber approximately the same size as the pile, and set upon the top of it. Under some circumstances an iron dowel is used, or a very broad band encircling both the top of the pile and the bottom of the follower. There are many objections to using a follower, and it should only be used when, from an economical standpoint or other circumstances, it is impossible to use timber of sufficient length to dispense with it. In using a follower, from half to three-fourths of the force of the blow is often absorbed in the follower itself, and is no way effective in driving the pile. This constitutes one of the greatest disadvantages connected with the follower. Another disadvantage is the great difficulty in driving the pile true, as far as its direction goes.

(TO BE CONTINUED.)

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 431.)

CHAPTER XXXV.

ACCIDENTS AND INJURIES TO PERSONS.

QUESTION 866. *In case an accident occurs and one or more persons are seriously injured, what can be done by those present?*

Answer. In such cases it very often happens that with knowledge, and sufficient coolness to apply that knowledge, one or more non-medical persons who are present when an accident occurs can do as much or more toward saving life and allaying pain *before* a doctor comes than he can *afterward*. The following cases cited by Dr. Howe in his book on "Emergencies" will illustrate this:

"*Case 1.*—A machinist was admitted to a New York hospital suffering from wounds of the wrist and palm of the hand. On arriving at the hospital the entire clothing on one side of his body was saturated with blood, from the loss of which he was partly insensible. On making an examination, it was found by the surgeon that a folded handkerchief was bandaged over the center of the wrist, and that the wound in the palm of the hand was untouched. The pad was placed on the wrist, as if the greatest care had been exercised to avoid pressing on either of the two arteries. The bleeding in this case could easily have been controlled if the bandage and pad had been properly applied. The patient, however, developed erysipelas, and not having sufficient vitality to carry him through, died the fifth day."

"*Case 2.*—A laborer fell from the front platform of a car at Harlem, and had his right foot crushed by one of the wheels. An ordinary bandage was placed on the limb, without any compress over the vessels. In bringing the man to the hospital, the rough jolting of the carriage set the wound bleeding, and by the time he reached his destination he was apparently lifeless. The vessels were tied and stimulants administered, but he never rallied. Death occurred six hours after his admission. His injuries, independent of the bleeding, might indeed have terminated his life; still the chances would have been in his favor if a compress had been applied to the limb to prevent bleeding. The fact that such a thing was not done shows either culpable negligence or deplorable ignorance."

Many similar cases constantly occur where a little intelligent, timely action of those present would save the life of an injured person, who without such help must die before professional surgical aid can be obtained.

QUESTION 867. *When it is found that one or more persons are seriously injured, what is the first thing to be done?*

Answer. The first thing to do is to extricate the person or persons from the danger, and at the same time send a messenger for a doctor. If it is doubtful if one can be obtained by sending in one direction, send two or more messengers in different directions.

QUESTION 868. *To what kind of injuries are locomotive runners and other persons employed or traveling on railroads exposed?*

Answer. They are liable to be bruised or crushed in case of collision or running off the track, or of injury from falling off the train, or of being run over by a moving train. Brakemen and others whose duty it is to couple cars are liable to have their hands, arms, or bodies crushed between the cars, and locomotive engineers are sometimes burned or scalded if an accident happens to their engines. Train-men are also frequently exposed to very great cold in winter and heat in summer, and are thus liable to be frost-bitten or sun-struck. Passengers are seldom injured excepting through their own carelessness, unless in cases of collision or running off the track and the destruction of the cars. Strangers and railroad employés are frequently run over by trains while walking or being on railroad tracks. It is estimated that from five to six thousand people are killed and wounded every year from "being on" railroad tracks. Frequent accidents occur to deaf people in this way, and it is not very unusual to hear of train-men who sit on the main track at night while their trains are waiting on the side-track for another train to pass, go to sleep while in that position, and then are run over by the passing train.

QUESTION 869. *How can accidents from being on the track be avoided?*

Answer. The obvious way is to stay off of railroad tracks, unless called there by duty, then to stay there as short a time as possible, and while there exercise the utmost vigilance to keep out of the way of moving engines and cars. It should be remembered that there is comparatively little danger to persons on engines or cars, but a railroad track is almost as dangerous as a battlefield to those on foot or who are traveling in wagons or carriages. It should be a universal rule with every person, whether a railroad employé or not, *always to come to a full stop before crossing or going on a railroad track.* If this rule was universally adopted many lives would be saved and much suffering avoided.

QUESTION 870. *When persons are crushed or dangerously wounded, what are the chief immediate sources of danger and death when their wounds are not necessarily fatal?*

Answer. First, excessive bleeding in case an artery is ruptured; second, the shock to the whole system, from which the sufferer may not have the strength to recover.

QUESTION 871. *When does bleeding from a wound become dangerous?*

Answer. Profuse bleeding is always dangerous, but it should be remembered that bleeding occurs from two sources: first from the arteries, which are the vessels which convey the blood *from* the heart, and second from the veins, through which the blood flows back to the heart. The first is called *arterial* bleeding and the second *venous* bleeding. Now it must be remembered that the heart is the great force-pump of the body, and that it supplies all parts of the body with blood, somewhat as the feed-pump of a locomotive supplies the boiler with water. The arteries referred to fulfil the same purpose that the feed-pipe does to a locomotive pump—they convey the fluid from the pump to the place where it is needed. Now the blood is forced into these arteries with a certain amount of pressure, so that if any of them are cut or injured the blood will flow out in a jet or spurt just as the water will escape from a feed-pipe if that is ruptured. The blood which flows through the veins back to the heart may, on the other hand, be compared to the water in the supply-pipes of a locomotive pump—that is, there is very little pressure on it, and therefore if they are injured the flow of blood from them is less rapid than from the arteries. It will therefore be seen that arterial bleeding is much more dangerous, because the blood flows from them under a pressure.

QUESTION 872. *How can arterial bleeding be distinguished from venous bleeding?*

Answer. The blood is of a bright scarlet color, and is forced out in successive jets; each jet corresponds with the movements of the heart. This characteristic spurting is caused by the intermittent force-pump action of the heart, driving out the blood. Venous bleeding is distinguished from arterial by the dark blue color of the blood when flowing from the wound. It never flows in repeated jets, but oozes slowly from the wounded surfaces. Venous blood is traveling toward the heart, and there is consequently little force behind to cause a more rapid flow. This form of bleeding is comparatively harmless, unless occurring from very large veins.*

QUESTION 873. *How can the bleeding be stopped in case an artery is cut or ruptured?*

Answer. The most efficient and available method is the application of PRESSURE on the artery BETWEEN THE WOUND AND THE HEART. Under ordinary circumstances this can be most effectively done by simply passing a handkerchief around the limb above the wound, or between it and the heart; the ends of the handkerchief are then tied together. A pad is then made, either of cloth rolled up, cotton waste, a piece of wood, or a round stone about the size of a horse-chestnut well wrapped, or any substance from which a firm pad can be quickly made, which is placed over the artery. The handkerchief, folded in the form of a bandage, is placed over the pad and passed around the limb and tied on the opposite side to the pad, and then a rounded stick about six inches long and three fourths of an inch in thickness is passed under the knot, so that the handkerchief may be twisted sufficiently tight to stop the bleeding by pressing the pad upon the artery; the twisting of the stick and the pressure upon the artery should only be sufficient to stop the bleeding from the artery; too much pressure or twisting would be painful and might produce other serious consequences. While the bandage is being prepared, some one should compress the artery with his fingers or thumb, so as to prevent as much loss of blood as possible.

QUESTION 874. *What is the position of the arteries in the body and how can their location be known?*

Answer. The position of the principal arteries is shown in fig. 439. They proceed from the heart *h*, with branches, *a a* and *b b*, which extend along each limb. These branches subdivide again below the knees and elbows, and again in the hands and feet. The position of the arteries can be felt by their pulsation at almost any part of them, but at some places they are covered so thickly by the muscles, that it is more difficult to feel their throb than it is where they are near the

* "Emergencies and How to Treat Them," by Joseph W. Howe, M.D.

surface. At *a* and *a* they are near the surface of the body, and also in the thighs at *b b*, and again at *c c*, immediately back of the knees, and in the wrists at *d d*. At these places the pulsations of the blood can be distinctly felt.

QUESTION 875. *In case of a wound and rupture of the arteries in the arm, what should be done?*

Answer. The artery should be firmly compressed at *a* with the thumb until a bandage and pad can be prepared. The pad should then be applied over the artery and compressed as explained in answer to Question 873. The bleeding can also be stopped by placing a round piece of wood or other form of

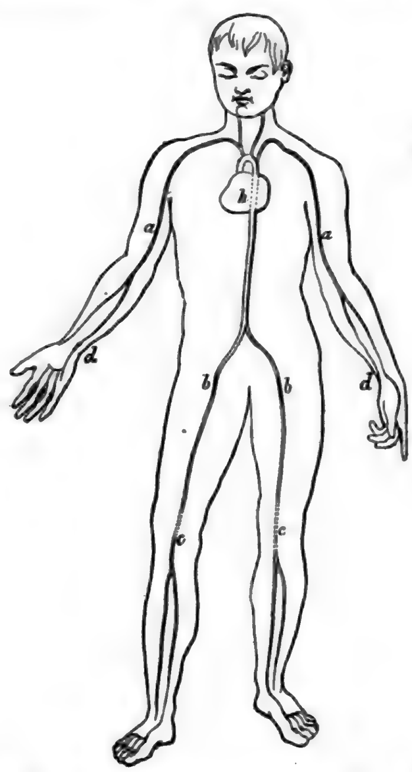


Fig. 439.

pad between the arm at *a* and the body and then tying the arm tightly against the body, so that the pad will be pressed against the arm.

QUESTION 876. *In case of rupture to an artery below the knee, where should the pressure be applied?*

Answer. The artery approaches near the surface at *c c*, immediately back of the knee, where it is represented in dotted lines in fig. 439. Pressure should therefore be applied at that point first with the thumb until a bandage can be applied. The bleeding can also be stopped by elevating the leg and allowing it to rest on the back of a chair or other similar support. The weight of the leg will then bring sufficient pressure on the artery to stop the bleeding. A towel or other soft material should be placed over the back of the chair, so that the pressure will not be too painful to the sufferer.

QUESTION 877. *If an artery is ruptured in the thigh above the knee, where should the pressure be applied?*

Answer. In the thigh at *b*, where the beating or pulsations in the artery can be distinctly felt. The reader should familiarize himself with the position of the arteries by feeling their location in his own body. By doing so he may be able to save his own life, the life of a companion or other person in case of accident, whereas without such knowledge the injured person might die.

QUESTION 878. *After the arterial bleeding has been stopped, if blood should continue to ooze out of the wound, what should be done?*

Answer. The wound should be filled with lint or clean cotton waste; and the limb then be bandaged by beginning at its extremity and wrapping the bandage closely and evenly around it, so as to bring, as nearly as possible, an equal pressure on the whole of it. Bandaging the limb in this way up to the point where the pressure is applied to the artery, will prevent swelling, and the veins will be compressed so that the blood will not flow from their torn extremities.

QUESTION 879. *When the bleeding has been stopped, what should be done?*

Answer. The injured person should be laid in as comfortable a place as can be procured for him, and should be given a moderate drink of water. If much exhausted, two or three tablespoonsful of brandy or whisky, mixed with an equal quantity of water, should be given first, and smaller quantities, *of not* MORE THAN A TABLESPOONFUL at a time, should then be given every half hour. Usually wounded persons are given too much stimulant, so that frequently they are injured more than they are benefited thereby.

After a person has lost much blood, he feels an intolerable thirst, but if too much water is given him, he is apt to become sick and vomit, which weakens him still more. It is therefore best to give him very little water, say a teaspoonful at a time, after the first drink, or if ice can be obtained, give the sufferer pieces of ice frequently, which can be allowed to melt, in his mouth.

QUESTION 880. *In case any bones are broken, what should be done?*

Answer. The limb should be supported as comfortably as possible until a doctor's services can be obtained. There is danger with a broken limb that the bones will protrude through the flesh and skin, to avoid which the limb should be placed in a natural position and laid on a pillow, car cushion, or other soft object. This should then be wrapped around the limb and tied in this position, so as to prevent any movement of the broken bones. A temporary splint may be made by tying an umbrella or light strips of wood to the broken limb.

QUESTION 881. *When a person is insensible, what should be done for him?*

Answer. Lay him down in as comfortable a place as the circumstances will permit, and protect him from cold, rain, or hot sun, as may be needed. A common error is to place injured and insensible persons in an erect position or in a chair. If he is insensible he should *always* be laid down with his head slightly lower than his body. Then water should be dashed two or three times on his face, and warm bricks, stones, or pieces of iron, such as coupling links or pins, applied to his feet, and in the arm-pits and between the thighs, being careful that the warm objects applied are not hot enough to burn. Then cover the person with blankets, heavy coats, or anything else which will keep him warm. Wounded persons soon become cold and chilled, the effects of which are very injurious, and therefore especial pains should be taken to keep them warm. In very cold weather there is great danger that injured persons will be frost-bitten, which must be carefully guarded against.

QUESTION 882. *What is meant by "shock" or "collapse"?*

Answer. Shock is a condition in which there is more or less diminished energy of the heart and circulation, and is the result of a severe impression made upon the nervous system, produced by either a physical injury or a mental emotion. The majority of cases met with are the result of extensive burns or other grave injuries, particularly those produced by gunshot wounds and railway accidents, which are generally associated with great laceration and crushing of the tissues, and mental excitement. Severe cases of shock may be produced by fright alone. Shock may be of a very mild character, as the result of a trifling injury or fright, the symptoms being hardly noticeable, of short duration, and demanding no treatment; or, it may assume a form which is rapidly fatal.*

QUESTION 883. *What are the symptoms of "shock"?*

Answer. In some cases, when the injury is slight, the symptoms may be hardly apparent, or, only a pale face and a weak and rapid pulse, a slight nausea, and a general sense of prostration may be produced. In cases of severe injury, such as might be caused by a serious railroad accident, the person injured is conscious, but dazed and flighty, cannot realize his condition, and apparently only appreciates loud and repeated questions; articulation is difficult, although there is no paralysis present. The sensibility to pain may be so blunted that an operation can be performed without the patient knowing it. The extreme pallor and coldness of the skin are startling; the surface of the body is covered with moisture; large beads of sweat cover the forehead; the pulse at the wrist may be lost, or, if perceptible, is weak, rapid, and irregular; the features are shrivelled, particularly about the nose, which appears pinched; the eyes are lusterless, sunken deeply in the sockets, and turned upward, the pupils being generally dilated. There is no other condition which so closely resembles death. The symptoms may continue for a few minutes or a number of hours, and often end in death.

QUESTION 884. *What should be done for a person in the condition described?*

Answer. Those in attendance should at once loosen the clothing, or cut it open rather than have too much delay, and make a rapid examination to ascertain whether severe bleeding exists,

*From a Manual of Instruction in the Principles of "Prompt Aid to the Injured," by Alvah H. Doty, M.D., published by D. Appleton & Co., New York.

or if one or more of the bones in the legs or arms are broken. If there is bleeding it should be stopped as already directed, or if any of the bones are broken a temporary splint should be applied as quickly as possible. The patient should then be carried to the most convenient and sheltered place within reach. While being removed the head should be as low as or some what lower than the body, or the extremities may be slightly elevated, so as to favor the flow of blood toward the brain. If possible, four persons should assist to carry the patient, one for each extremity and the contiguous portions of the body. His clothing should be removed and he should be made as comfortable as possible, and kept warm by proper covering and applying bottles of hot water, warm coupling-pins, links, or other pieces of iron, or bricks, or stones. These should be placed about the arms and legs, inside the thighs, and under the armpits and about the body, but not about the head, as this might favor congestion when reaction occurs. If heat cannot be applied as described, the injured person should be rubbed in order to excite circulation. If able to swallow, he should be given about two teaspoonfuls of whisky or brandy, with a small amount of hot water, or, still better, hot milk; this may be repeated every ten or fifteen minutes, until four or five doses have been taken, or reaction becomes apparent. When the latter occurs, the stimulant should be diminished or discontinued. When reaction occurs, the color and warmth gradually return to the skin, the eyes are brighter, and the symptoms indicate an approach to the normal condition. Vomiting is regarded as a favorable symptom and generally denotes reaction. This does not always insure safety, and the sufferer should be carefully watched. When reaction has taken place warm beef-tea, broth, or milk should be given in small quantities.*

All assistance and attention should be given to a wounded person with the least noise and excitement, and all crowds and idle spectators should be driven away and every effort made to keep the sufferer comfortable and quiet.

QUESTION 885. *If a person is crushed or severely burned, what should be done?*

Answer. The immediate danger from such injuries arises from the "shock" to the system. It is usually best to bandage the part which is crushed until surgical aid can be obtained, and the sufferer treated as explained in answer to Question 884.

QUESTION 886. *What should be done for a person who has been burned or scalded?*

Answer. The wound should be dusted with bicarbonate of soda (common baking soda, *not washing soda*), wheat flour, starch, chalk, or charcoal, and then dressed with lint or clean cotton waste and loosely bandaged. Vaseline, cosmoline, olive or linseed oil, or molasses may be employed for dressing burns or scalds. If blisters are produced the clothing should never be forcibly removed from them, but carefully cut off with scissors as close to the burn as possible. The small pieces adhering to the skin may be afterwards washed away with warm water, or softened with oil and detached later. If the blisters are large, they should be pricked at their lowest part and the contents allowed to escape. The oily substances already recommended should then be applied as described.*

If the injury should be severe, a shivering, followed by depression, is very likely to come on. To check this, warmth in the form of hot applications and stimulants should be used, as already explained.

QUESTION 887. *What should be done for a frost-bite?*

Answer. Warmth should be applied to the frozen part very gradually by rubbing with snow or pouring cold water on it. The occurrence of stinging pain, with a change in color, is a signal to stop all rubbing or other measure which might excite inflammation. If the frozen part turns black the next day, a poultice should be applied.

If persons exposed to the cold become very much exhausted or sleepy, stimulants should be given, as explained in answer to Question 884, and the body briskly rubbed with the hands and warm flannel or other woolen material.

QUESTION 888. *How should a person be treated who has been sun-struck?*

Answer. Apply cold water or ice to the head, place the sufferer in a cool place, and make him comfortable. After being sun-struck the person should not work for some days or weeks thereafter, until his health and strength are fully recovered.

QUESTION 889. *How should persons who have been under water for a short time, and unconscious when taken out, be treated?*

Answer. Persons who have been under water for four or five minutes or more are not usually restored to life, although numerous cases are recorded where resuscitation was effected after an interval of twenty minutes. If they have been under water but a few moments, the water, mud, and mucus should be removed from the mouth and nose and the tongue should be pulled forward and the person should be turned on his side, face downward, to allow the water to escape. He should then again be turned on his back, while the hands of the attendant are placed on the belly and pressure directed upward and inward toward the diaphragm. This movement tends to stimulate respiration, and should be repeated two or three times at intervals of two or three seconds. The mouth in the mean time should be kept open by a cork or piece of wood, or a knot tied in a handkerchief, etc., in order that the passage of air to the lungs should not be interfered with. Tickling the nose with a feather or straw also stimulates breathing. When breathing commences and consciousness returns, the patient should be carefully divested of all wet clothing as soon as possible, be well rubbed, and wrapped in warm covering, and stimulants be given in the manner already described for cases of "shock."

If these simple measures are productive of no good result after a short trial, artificial respiration should be at once resorted to.

Before artificial respiration is begun, the patient should be stripped to the waist, and the clothing around the latter part should be loosened so that the necessary manipulations of the chest may not be interfered with.

The water and mucous having been removed from the mouth and throat as described, the patient is to be placed on his back, with a roll made of a coat or shawl under the shoulders; the tongue should then be drawn forward and retained by a handkerchief, which is placed across the extended organ and carried under the chin, then crossed and tied at the back of the neck. An elastic band or small rubber tube or suspender may be substituted for the same purpose. If no other means can be made available, a hat or scarf-pin may be thrust vertically through the end of the tongue without injury to this organ. The attendant should kneel at the head and grasp the elbows of the patient and draw them upward until the hands are carried above the head, and kept in this position until one, two, three can be slowly counted. This movement elevates the ribs, expands the chest, and creates a vacuum in the lungs into which the air rushes, or, in other words, the movement produces *inspiration.* The elbows are then slowly carried downward, placed by the side, and pressed inward against the chest, thereby diminishing the size of the latter and producing *expiration.* These movements should be repeated about fifteen times during each minute for at least two hours, provided no signs of animation present themselves.

If after using the above method evidence of recovery appears, such as an occasional gasp or muscular movement, the efforts to produce artificial respiration must not be discontinued, but kept up until respiration is fully established. All wet clothing should be removed, the patient rubbed dry, and if possible placed in bed, where warmth and stimulants can be properly administered.*

CHAPTER XXXVI.

RESPONSIBILITY AND QUALIFICATIONS OF LOCOMOTIVE ENGINEERS.†

QUESTION 890. *What are the dangers to which the engineer and the fireman are exposed by their work on the engine?*

Answer. Engineers and firemen are not only exposed to great bodily injury or even death by every accident which may happen to their engine, but unless they are very careful to preserve their health it is quickly destroyed by the constant changes of the weather to which their position exposes them, and also by the effect of the heat of the fire and by the smoke by which they are often surrounded.

In order to protect themselves in a measure from the injurious effects of change of weather, smoke, cold, etc., frequent bathing and cleansing of the skin are absolutely necessary, and also the wearing of a woolen undershirt next the skin at all seasons.

The gases of coal which pour out of the furnace-door, if it is opened when the throttle is closed, have an especially injurious effect on the throat, lungs, etc. They should see to it, therefore, that the blower is always started before the fire-door is opened, in order that these injurious gases, which have collected during a halt, may be drawn forward and up the chimney by the draft.

The steady, loud clatter which the engine makes while running has an injurious influence on the nervous system. The engineer should therefore endeavor to lessen these shocks of the engine as far as possible by keeping watch over it and keeping its parts accurately adjusted. In order to keep himself fresh and strong in his service, which is extremely exhaustive

* From "Prompt Aid to the Injured," by Alvah H. Doty, M.D.

* From "Prompt Aid to the Injured," by Alvah H. Doty, M.D.

† A considerable part of this chapter is a translation from Professor George Kosak's "Katechismus der Einrichtung und Betriebes der Locomotive."

to body and mind, the engineer should try to strengthen himself by regular, temperate living, and eating abundant nourishing food. The common use of strong drinks, which undermines the mental and physical strength of men, should be avoided by a person occupying the exhaustive and responsible position of a locomotive engineer. If in ordinary life a drunken man is unfit for any simple work, how shall a drunken engineer or fireman undertake the difficult management of so great, so delicate, and so costly a machine as a locomotive? How can hundreds of men quietly trust their lives and limbs to such a man, whom no one can help despising? Rightfully, therefore, conscientious railroad managers place the greatest stress on the *sobriety* of the engineers and firemen, and instantly discharge from their service those who give themselves up to a passion for drink.

Owing to the demands which their daily labor makes upon their strength and endurance, locomotive engineers should be careful not to increase the drain by dissipation, irregular hours, or overwork. There seems to be something about the power of endurance of the human frame analogous to the capacity of a bar of iron or steel to resist strains. So long as the strains do not exceed the elastic limit—that is, if the bar recovers its original length when the strain is removed, it will bear millions of such strains without becoming weaker; but if it is strained so hard that it is permanently stretched, then comparatively few applications of the force will rupture the bar. In a similar way, if the strain or fatigue which a man endures is no more than he will recover from after the ordinary rest, he can endure an almost unlimited number of such strains, but if the fatigue exceeds his "elastic limit," then he soon becomes permanently injured thereby. It often happens that an excessive amount of work is unavoidable, but when it can be avoided it should be by those who wish to preserve their health and strength.

In order to save themselves from great injuries, engineers and firemen should always act with the greatest caution, and never rush carelessly into danger. They should never adopt the principle of foolhardy and thoughtless people, who by the consciousness of continual danger fall into the habit of carelessly "trusting to their luck," etc. On the contrary, they should always face the danger with their eyes open and with the greatest conscientiousness. Many try to show great courage by scorning the danger, and some such even wish to meet a little in order to be able to show that they are not afraid. These should bear in mind that they have a great responsibility laid upon them, and that it is not alone their own well-being or life which is at stake in case of any mishap, but that by their careless behavior they may wound or kill the helpless people who are committed to their care, cause incalculable misery by obbing families of their sole support and of their children; and bring great sorrow and mourning to their fellow men. The thought of the curse and the despair of the survivors may give sleepless hours even to a locomotive engineer who knows himself to have been without any fault regarding an accident; how much more must it be with him who cannot give himself this assurance? There are not wanting instances in which the engineer who caused such an accident by his thoughtlessness, driven to despair by his own heavily-burdened conscience, went miserably to ruin.

QUESTION 891. *What should a locomotive engineer and fireman do to preserve their health?*

Answer. The following excellent suggestions * to workingmen for the *prevention* of sickness may be followed by all locomotive engineers and firemen, to their own great advantage and that of their families.

They include, first, attention to home surroundings, and second, to personal habits.

In regard to the first, one of the earliest physicians, Hippocrates said that the essentials of health were pure air, pure water, and a pure soil. Your home should, above all hings, be free from damp. It should not be built upon made land or where it can be flooded by rains or by a rise of tide. Dampness is a certain source of consumption, rheumatism, croup, diphtheria, and other diseases. The nearer your living-rooms are to the ground, the more danger there is of damp. It is better to occupy an attic where you can get the sun and the air than a basement.

Again, new houses are liable to be damp from the evaporation from the plaster and mortar, which contain a large amount of water. A Spanish proverb says of new houses, "The first year for your enemies, the second year for your friends, and the third you may live there yourself." Again, cellar air is unwholesome; and this is another reason why basement rooms are bad. It is very unwise to store vegetables in cellars, or anything that will cause impurity of the air.

Pure air is the most vital thing of all. One may live without proper food and drink, and on a damp soil with impunity, but foul air slays like a sword. Every person needs pure air to breathe. Each time we empty our lungs a certain amount of impure air is thrown off. Thousands die yearly for lack of pure air. It is free to all; it costs nothing. Open the window, and it flows in abundance to the beggar as to the millionaire, bringing health and life to all—if only people would not shut and bar it out in their blind, stupid ignorance.

What is it that makes most people sick? Eating too much and too fast; drinking too much; want of fresh air; want of sunlight; want of exercise; want of cleanliness. Few persons die of starvation—many do of gluttony.

Bathe as often as you can.* Remember "cleanliness is next to godliness," and a foul body means a foul mind. Keeping the pores of the skin open is a prime element of health. How carefully we groom our horses! and is not a man's health as precious as that of a horse?

Let your wife and children have as much out-door exercise as they can get. It will be a change, and won't do the least harm.

Don't sit in damp clothes if you come home wet. If you feel chilled and cold, soak your feet in a pail of hot water, then go to bed and pile on the clothes till you sweat, and you will escape catching cold. In such cases, hot tea, or coffee, or soup is better than whisky to warm you. In cold countries tea is preferred to any drink. Liquor should never be taken by a sick person, unless by a doctor's orders.

Clothes should fit loosely, should be light, warm, and porous, should be adapted to the season as to color, should be frequently changed, and should be scrupulously clean.

In cooking, use the frying pan as little as possible; greasy food is very unwholesome. Avoid too much pork and liquors.

Eat slowly, chewing the food well, and drink very little liquid of any kind while eating. Tea is not food, and too much of it is drunk by many persons, especially women and children. Eat oatmeal and hominy in preference, and give children plenty of milk. Beans are very nutritious.

Don't shut every cranny and crack to keep out the air from the rooms, but let the windows stay open for a time.

Don't forbid the blessed sun from entering your windows. Don't stay in a house that has a bad smell in it.

Don't live in dark, gloomy, close rooms if you can get sunny, cheery ones.

Remove all garbage and refuse as soon as possible from your houses.

Have the walls and ceiling whitewashed or kalsomined once or twice every year.

In looking for apartments, always strive to secure a well-ventilated bedroom. Air the room and bed-clothing every morning. Keep as few clothes, not in use, as possible in the bedroom, and do not sleep in any garment which is worn by day.

QUESTION 892. *What requirements and duties should every locomotive engineer fulfill?*

Answer. Every locomotive engineer should fulfill the following requirements and duties:

1. He should have an exact knowledge of the engine intrusted to him, and a general knowledge of the nature and construction of steam-engines generally. Likewise, he should be perfectly familiar with the management of the boiler, the running of the engine, and the way of keeping the working parts in good condition; also, with the forms and peculiarities of the line of road on which he runs, the rules which govern the running of trains and with the signal system adopted.

2. *Health* and *bodily strength* he must have in abundant measure in his position, which is exhausting and in which he is exposed to all sorts of weather.

3. He should have at least a good, plain common-school education, and be ready at reading, writing, and arithmetic.

4. He should always carry out *exactly* and *cheerfully* the regulations of the service, or the instructions given him by special orders from the officers over him.

5. *Faithfulness, frankness, and honesty*, which characterize an upright man in ordinary life, and also the strictest *temperance* in the use of strong drink, he should possess in a high degree in his very responsible position.

6. He should have acquired a certain degree of skill in putting together and taking apart locomotives, and also in repairing separate parts of them. It is desirable that he should always be present when his own engine is taken apart, put together, or repaired, in order that he may acquire a thorough knowledge of its condition and learn to understand properly the importance of its various parts.

7. In caring for his engine, he must preserve perfect cleanli-

* Published by the Citizens' Sanitary Association of Brooklyn, N. Y.

* If a bath tub is not available, a damp or wet towel—the coarser the better—rubbed briskly all over the body every morning is an excellent substitute for a bath.

ness and order, and in using fuel he must manifest the greatest care and rigid economy.

8. Whenever there is danger, coolness and self-possession are indispensably necessary, and any thoughtlessness or recklessness is to be strictly avoided.

9. Toward his superior officers his behavior should be respectful and obliging; toward those under him, patient and kindly, and at all times he should avoid profanity and all intemperate language. He should endeavor, as far as possible, to instruct the fireman who accompanies him and make him familiar with the construction and management of the engine, and should see that he does his work strictly in accordance with his instructions.

It is the *fireman's* duty to follow the engineer's instructions strictly, and in case of any sudden disability of the engineer he must stop the engine in accordance with the instructions given him, and then give the proper signals for help, until another engineer arrives. In the meanwhile the engine is to be kept at a halt with all the usual precautions.

10. The egnineer should try to keep himself informed of the progress and improvement of locomotives by reading suitable books and technical periodicals, and when possible acquire some skill in geometrical and mechanical drawing, in order to accustom himself to accurate work and sound and systematic thinking.

QUESTION 893. *What studies should mechanics, locomotive engineers, and firemen take up, and what technical books should they read?*

Answer. As already stated, they should know how to read and write their own language, and understand arithmetic and have some knowledge of geography. Every locomotive runner and fireman has a good deal of spare time, a part of which he can devote to study, and all of them, even if they have not had the advantage of early education, could by industry and perseverance acquire a knowledge of "reading, writing, and ciphering." The assistance of a good teacher should always be procured, if possible. With so much knowledge, some book on natural philosophy can be read to advantage, and then some book on mechanics. It should always be remembered, however, that the mere buying of books contributes very little knowledge to the owner. It is the reading and *understanding* them which "increases knowledge." Before buying books it will be well to ascertain from persons capable of judging of their character, whether they are worth buying, as there is more difference in the quality and character of books than there is in almost any other commodity which is sold. Many which are written and published are not worth buying or are unsuited to the wants of the purchaser, while a really good book—and there are many such—is a treasure.

CHAPTER XXXVII.

THE CARE OF LOCOMOTIVES WHILE IN THE ENGINE HOUSE.

QUESTION 894. *How can defects, such as cracked plates or dangerous corrosion, be discovered in a locomotive boiler?*

Answer. Such defects are usually indicated by leakage while the engine is in service. They are shown by a little water or steam oozing at the point where the defect exists. When the engine is cold a slight collection of incrustation or rust on the outside of the boiler will show that there has been a leak. A defect in the fire-box will often be shown by a leak at the mud-ring. When a fire-box plate is cracked it usually opens suddenly, so that the leak shows at once. Tubes are liable to leak when there is no other defect excepting that they need calking, but when this is done the tube-plate should always be examined to see whether it is cracked.

QUESTION 895. *How can internal corrosion or grooving be discovered?*

Answer. Unless it has become so serious as to cause an external leak, this cannot be discovered excepting by an internal inspection of the boiler. To do this the dome-cover must be taken off and a person must go inside of the boiler and examine carefully every part that is accessible. To make an internal inspection thorough the tubes must be taken out. When water is of a corrosive character, or contains much solid matter which is deposited inside of the boiler, such an inspection should be made frequently, but when the water is pure it is not essential to do it often.

QUESTION 896. *How can defects in braces or stays or broken stay-bolts be discovered?*

Answer. Broken braces and stay-bolts are indicated sometimes by the bulging of the plates of the flat parts of the boiler. Broken stay-bolts may often be discovered by an expert by sounding them with a hammer, and if their ends are drilled, as explained in answer to Question 178, their fracture is shown by the leakage. An internal inspection is the only way of being sure that the braces are in good condition.

QUESTION 897. *What must be done to prevent the inside of the boiler and the tubes from becoming covered with incrustation?*

Answer. The first and most effective preventative is to get the purest water that is obtainable for use in the boilers. Having done this, if it contains much solid matter, the boiler must be blown out and washed out often. If the water forms a solid deposit it will be necessary to take out the tubes and crown-bars at intervals, and clean them and the inside of the boiler thoroughly.

QUESTION 898. *What should be observed with reference to the smoke-box?*

Answer. It should be noticed whether the front and door are securely fastened so as to be air-tight. If air leaks into the smoke-box the sparks or cinders are liable to take fire on the inside of it, which heats all the parts about it, blisters the paint outside, may cause the steam and exhaust-pipes to leak, and destroy the wire netting. It should also be observed whether the convey or exhaust-pipes, dampers, netting, etc., are in their proper position and securely fastened.

QUESTION 899. *What may happen to the convey or exhaust-pipes?*

Answer. They may get loose or may require adjusting. Moving them up or down has an important influence on the draft, but experience is the best teacher with reference to their adjustment.

QUESTION 900. *What may happen to the wire netting in the smoke-box or in the top of the chimney?*

Answer. It wears out often and gets holes in it which allow sparks to escape. When the engine "throws fire" from this cause the netting should be renewed. If the engine "works water" the netting is liable to get clogged. Unless oil from the cylinder gets into the netting the obstruction can usually be beaten out, but if the latter has oil in it, it can be burned out by building a fire on it, as explained in answer to Question 768.

QUESTION 901. *What should be noticed in connection with the steam and exhaust-pipes?*

Answer. The steam pipes should be kept tight. If they leak the joints must be reground. Exhaust nozzles sometimes get obstructed by a collection of oil and dirt, which should be cleaned out. It should also be noticed whether the nozzles are located so that the blast from the exhaust-pipes is discharged in the center of the chimney.

QUESTION 902. *To what casualties are the grates liable?*

Answer. To being burned out or broken. If this occurs bars must be renewed.

QUESTION 903. *How often should the tubes be cleaned?*

Answer. That depends very much upon the kind of fuel used, as some coal fills up the tubes much more than other kinds do. Every time the engine is washed out the tubes should be thoroughly cleaned. To do this the smoke-box must be opened and the exhaust or convey-pipes be taken down. If the fuel used leaves considerable deposit in the flues, it is well to brush them out as thoroughly as is possible from the furnace-door.

QUESTION 904. *How may a throttle-valve get out of order?*

Answer. They are liable to leak, and if they do they must be reground. A disconnected throttle is now a rare occurrence, but it should be certain that the connections are all right.

QUESTION 905. *What kind of attention must be given to the safety-valves?*

Answer. They should be adjusted so as to blow off at the required pressure, and it should be known whether the springs retain their elasticity, as it is affected by the heat of the steam, which makes it essential to renew them occasionally. One of the safety-valves should have a lever or other appliance for opening it in case it is necessary to relieve the boiler of pressure.

QUESTION 906. *What is essential with reference to steam gauges?*

Answer. Their most important function is to indicate the steam pressure correctly, and to be certain that they do this, they should be tested frequently. When this is done the date should always be marked on the back of the gauge, or some other record of it should be kept.

QUESTION 907. *What kind of attention should be given to the other boiler attachments?*

Answer. The whistle-valve should be kept tight, the gauge-cocks should be kept clear by running a wire through them, and the glass water-gauge should be blown out occasionally. A careful engineer will always know whether the injectors work satisfactorily, and if either of them is out of order it should be taken off and a spare one substituted in its place. Check-valves should be taken down occasionally and cleaned, and it should be observed whether the blower-valves and pipes are in good condition.

QUESTION 908. *What must be done to keep the insides of the cylinders in good condition—that is, to prevent them from cutting?*

Answer. They must be well lubricated when not using steam, and the packing must be properly set up, not so tight as

to bind nor so loose as to blow, or allow the piston-heads or followers to rub on the bottoms of the cylinders, as the two cast-iron surfaces will scratch each other. It is also important that the piston be central in the cylinder; if anything, have it a little higher than central. It should be set by callipering on the projection on the front side, which holds the follower-plate in place.

QUESTION 909. *What is meant by piston-packing being "follower-bound"?*

Answer. It means that when the follower-plate is bolted up hard against the piston-head that it clamps or binds the packing-rings between the plate and the piston-head so that the rings cannot move.

QUESTION 910. *How can it be known whether the packing is follower-bound?*

Answer. When the packing can move as it should between the piston-head and follower-plate its movement is usually shown by marks on the follower-plate when it is taken off. If such marks are not apparent, and there is reason to think that the packing is too tight, the piston should be taken out, the packing put in place, and the follower-plate bolted on. The packing should then be loose enough, so that it can be moved by tapping it with a piece of wood. If it is too tight a piece of paper should be inserted between the follower-plate and piston-head where they are in contact with each other.

QUESTION 911. *What kind of attention should be given to piston-rods?*

Answer. They should be oiled occasionally and kept keyed up tight in the cross-head and piston.

QUESTION 912. *What must be done to keep the cross-head slides and the guide-bars in good condition?*

Answer. They must be "in line" or parallel with the center line of the cylinder and they must be kept well lubricated. A little lost motion in the guides is not a serious evil unless it becomes excessive.

QUESTION 913. *What kind of attention should be given to the crank-pins and connecting-rods?*

Answer. They are all liable to break, and they should be examined often to see whether there are any cracks or flaws in them. Whenever the rods are taken down the straps should be looked over carefully, especially in the inside corners, to see whether any flaws exist. Main-rods are less liable to break than coupling rods. If there is any lost motion in the brasses of the main-rod they should be filed off on the faces, and keyed up so as to bear against each other hard without binding on the journal. They must be filed square, and the best plan is to put them on the journal and key them up in the strap alone without the rod. They can then be easily moved around the pin, to see whether they bind. Lost motion in a main connecting-rod will cause a thump, but a little play in coupling-rods will do no harm. It is better to have the bearings of coupling-rods too loose than too tight. If the coupling-rods have solid ends and bushings they require no attention excepting oiling, and when the bushings are worn too much they should be taken out and replaced with new ones.

QUESTION 914. *What must be done to keep oil cups in good condition?*

Answer. The principal thing to do is keep them clean, free from dirt and gum, and adjust the spindles—if they have any—so as to feed the right quantity of oil.

QUESTION 915. *How should the valve-gear be taken care of?*

Answer. The principal defects of valve-gear are due to want of proper lubrication. It should be examined carefully, and if there are any indications that the eccentric straps or any of the pins are cutting they should be taken apart, examined, and thoroughly oiled. It is usual now to key eccentrics fast to the axle so that it is impossible for them to slip. If they are fastened with set screws alone they should be examined occasionally to see whether they have moved from their original position.

QUESTION 916. *What is meant by an engine "going lame"?*

Answer. It means that one of the four blasts of steam from the cylinder are not equal, so as to give the sound of the exhaust an irregular or limping sound.

QUESTION 917. *To what cause is "going lame" generally due?*

Answer. It may be because one or more eccentrics are not set right or a valve-stem or eccentric-rod is too long or too short. Sometimes it is due to lost motion in the valve-gear, or the links may be suspended in such a way, that when the reverse-lever is in a given position one of them hangs lower than the other. To guard against the latter evil it should be observed, in setting the valves, whether they cut-off at the same points of the stroke on each side of the engine.

QUESTION 918. *What are the principal causes which make an engine "pound" or "thump"?*

Answer. It is generally due to lost motion somewhere. If an engineer hears a "knock," he should examine to see whether there is lost motion in either of the ends of the main connecting-rods. Lost motion in a coupling-rod is not liable to cause a thump, although they may be so loose that their side motion may make them rattle. Lost motion in the driving-boxes—that is, either in the bearings or wedges—a loose piston-rod in the cross-head or piston may cause a "pound." The most difficult cause to discover is when the piston-rod gets loose in the piston, because it cannot be examined when the engine is working. If a piston strikes the cylinder-head it will also cause a "knock." By reversing the engine with a little steam on when it is standing still, it can be seen whether there is lost motion in the driving-boxes, and by watching them carefully it can be seen whether they are loose between the wedges or on the journal of the axle.

QUESTION 919. *How should the running-gear be taken care of while the engine is in the shop?*

Answer. First the journals of the axles must be kept well oiled. The oil-cellars should be taken down occasionally and cleaned. They should be packed with woolen waste, which has more elasticity than cotton and bears against the axle, while cotton waste packs down solid. With the heavy loads now carried on the driving-axles of some locomotives there is often much trouble from the journals heating. This is often due to the want of end play between the boxes and hubs and collars on the axles. This play should be about $\frac{3}{16}$ of an inch. The driving-boxes, tires, wheels, and axles should be examined often to discover flaws, as they are liable to break. Tires are most liable to split circumferentially or "bulge" sideways. An engineer should always be vigilant to detect circumferential flaws or any bulging, which usually indicates the beginning of a fracture. The breakage of engine axles usually occurs just inside of the hub. When the oil-cellars are taken down the portions of the axles which are inside of the box should be examined carefully for cracks or flaws.

QUESTION 920. *What precaution must be taken with reference to springs, hangers, and equalizers?*

Answer. Like all other parts, they should be examined often to see that they are in good condition, and it should be observed whether the springs come in contact with the boiler—if they are apt to rub against it and cut a hole in it.

QUESTION 921. *To what danger is the coupling between the engine and tender liable?*

Answer. The coupling-pins in time wear so much as to be seriously weakened, and draw-bars are liable to break, especially if they are not made heavy enough.

CORRECTION.

In the answer to Question 620, published in the number of the JOURNAL for February of this year, the fourth paragraph should be corrected so as to read as follows:

"To get a measure of the cylinder capacity which will also take the steam pressure into account, we should multiply the modulus of propulsion by the maximum boiler pressure per square inch. This product has been named the *modulus of traction*. Thus in the first example the boiler pressure was assumed to be 150 lbs., and therefore $3.68 \times 150 = 552$, in the second it was 140 lbs., so that $4.05 \times 140 = 567$. Experience seems to indicate that a modulus of traction of about 550 will give very good results in practice."

The error was in directing that the modulus of propulsion should be *divided* by the maximum boiler pressure instead of *multiplying* it.

(THE END.)

Manufactures.

Manufacturing Notes.

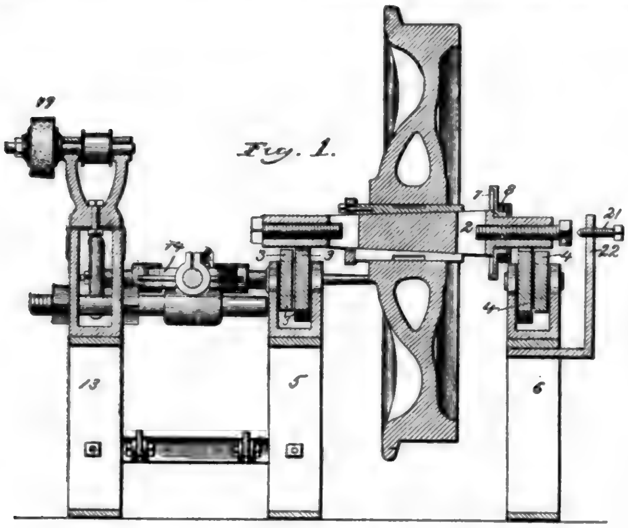
THE Pond Engineering Company, St. Louis, has plenty of business on hand. The Company has recently sold an Armington & Sims engine of 125 H. P. to the Electric Light Company, Fort Scott, Kan.; also a 50-H. P. engine, with an inside steam condenser, etc., to a firm in Milford, Ia. The Company has a contract for the engine and boilers for the water-works at Belleville, Kan., and has furnished leather-link belting to the Edison Illuminating Company, Topeka, Kan., and a Tracey oil filter to the Metropolitan Railroad, Kansas City. Its latest contract is for an Armington & Sims engine of 100 H. P. for the Water & Light Company at Hutchinson, Kan. This engine has a special feature—a clutch placed on the driving-wheel so arranged

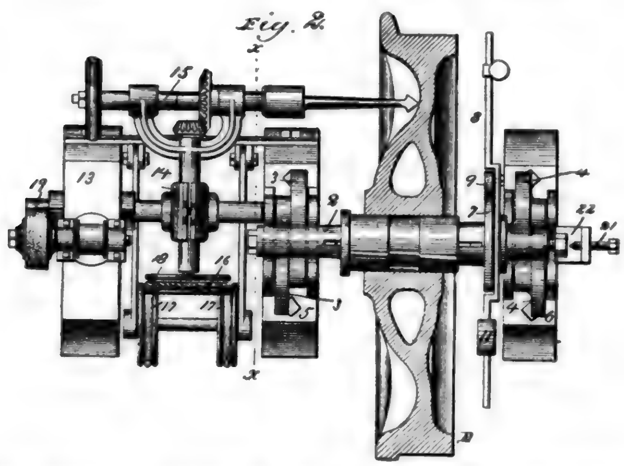
that with the engine running steadily the driving-wheel can be run as desired.

THE Llewellin Machine Company, Bristol, England, is making a time-checking machine which has met with much success there, and is now being introduced in this country by E. P Spaulding & Company, of New York. This contrivance registers the time of arrival of each workman in the shop, the man putting a check, with his number or some other mark, into a slot in the machine. One of these contrivances has been in use some time in the Crump Label Works at Montclair, N. J., where some 300 men are employed, and no mistake has ever been detected.

ARRANGEMENTS have been made to supply the city of Fort Wayne, Ind., with natural gas brought from wells 40 miles distant from the city. The pipes will be laid on the right of way of the Fort Wayne, Cincinnati & Louisville Railroad.

THE shops of Pedrick & Ayer, in Philadelphia, have become entirely too small for their increasing business, and the firm





have therefore removed from their old quarters to new shops at 1,001 and 1,003 Hamilton Street, and 1,002 and 1,004 Buttonwood Street, Philadelphia, where they have now ample facilities for turning out a large quantity of work and filling all orders.

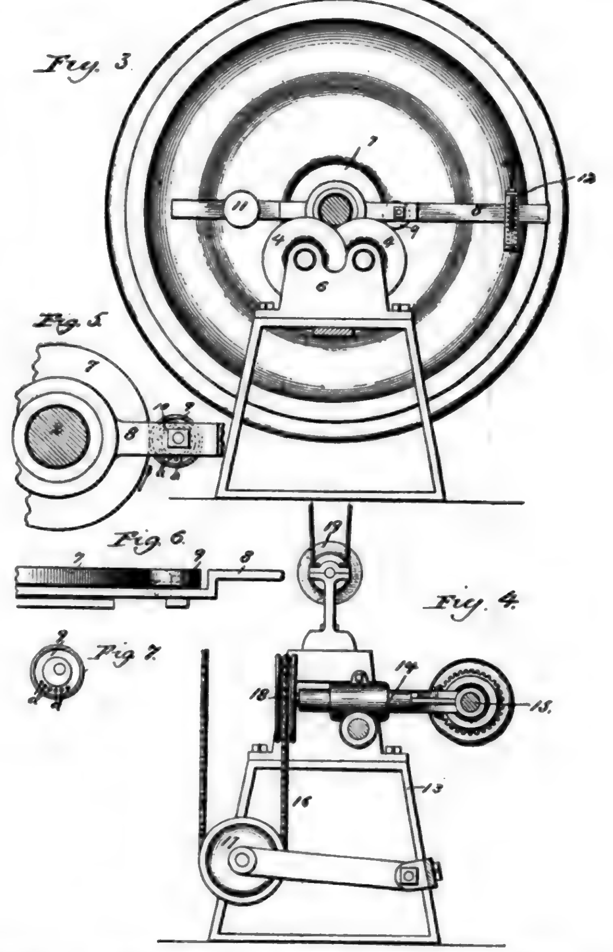
Balancing Apparatus for Wheels.

THE accompanying illustrations show an apparatus for balancing wheels, pulleys, etc., recently invented by Thomas A. Griffin, of Chicago, and covered by patent No. 407,589, issued under date of July 23 last.

The wheel is mounted for balancing upon an expanding mandrel, though an ordinary mandrel will answer.

In the accompanying drawings, fig. 1 is a vertical longitudinal section of the improved apparatus, showing a car-wheel in position for balancing. Fig. 2 is a plan view of the apparatus, the car-wheel being shown in section. Fig. 3 is an elevation looking from the right of fig. 2. Fig. 4 is an elevation of the part to the left of the dotted line $x\ x$, fig. 2. Figs. 5, 6, and 7 are detail views on an enlarged scale.

The ends of the mandrel 2 rest on anti-friction rollers 3 3 4 4, journaled in the standards 5 6, which constitute a part of the frame of the machine. A disk 7 is rigidly secured to the mandrel 2, and a lever 8 is hung thereon so that it may vibrate in proximity to the disk. Upon the lever 8 is pivoted an eccentric 9. whose edge is in contact with the edge of the disk 7. The structure of the eccentric 9 is shown in figs. 5, 6, and 7. A curved or coiled spring 10 (seen in dotted outline in fig. 5), one of its ends being inserted in one of the holes $a\ a$, etc., in the eccentric, and the other end in the arm or lever 8, maintains the contact between the disk 7 and eccentric 9. The eccentric 9 is thus adapted to act as a friction-clutch, and is arranged so that when the lever 8 is moved in the direction of the arrow, fig. 3 or 5, the disk 7 and the attached mandrel and pulley or wheel will be rotated, while the lever will be freed when moved in the opposite direction. The lever 8 projects on both sides of the mandrel 2, one end being provided with a balancing-weight 11, by which the lever itself may be poised, while the other end is provided with a spring-scale 12, or other device, by which the force applied in turning the mandrel and pulley may be determined. The balancing of the lever 8 by the weight 11 is not



essential, as will be evident when the operation comes to be considered; but is a convenience, because the scale will then correctly indicate the force required to rotate the mandrel.

Mounted at the rear of the apparatus between the standards 5 and 13, figs. 1 and 2, is a drilling-machine 14, the drill-spindle 15 of which is made adjustable by well-known devices, so that it may be fixed at any angle or in any position within its range. Power for driving the drill is transmitted through the rope 16, passing round the pulley 18 and tightener-pulleys 17, figs. 2 and 4. An emery-wheel 19 is also mounted at the rear of the machine, and is used for fitting and reducing the counterbalance-weight when the precise weight needed has been ascertained.

The mode of using the apparatus hereinabove described is as follows: The mandrel 2 is driven into the wheel or pulley to be balanced and placed upon the rollers 3 3 4 4. The spring-scale 12 is slid along the lever or scale beam 8 to any convenient point, varying with the size and weight of the pulley operated upon, but preferably to a position corresponding to the radial distance proposed for the counter-weight. Pressure barely sufficient to turn the mandrel is applied to the spring-scale and its reading noted. Another portion of the pulley or wheel is then brought uppermost and the pressure required to turn it again noted. Several diametrically opposite points are thus tested. As the frictional resistance is the same for all

positions, the comparison of the different readings will show the location of the heaviest spot, and one-half the difference between the greatest and least opposite readings will be the amount of counterbalance needed if placed at the radial distance of the weighing-scale. A weight of the proper size, being selected or prepared by grinding on the wheel 19 or otherwise, is then temporarily secured to the pulley or wheel, and if desired its sufficiency tested by noting whether the pressure required to revolve the wheel is the same in all positions. The counterbalance-weight is then permanently secured by drilling through it and the wheel before the latter is removed from the balancing-machine and inserting a rivet or other fastening. The thrust of the drill against the wheel is taken by the screw 21, passing through the brace 22, figs. 1 and 2, and abutting against the end of the mandrel.

Soule's Rail-Joint.

MR. RICHARD H. SOULE, of Pittsburgh, Pa., has patented the rail-joint illustrated herewith, which is described as follows in his specification :

"In the accompanying drawings, forming a part of this specification, fig. 1 is a view in elevation of a rail-joint having my invention applied thereto. Fig. 2 is a view of the same, partly in section and partly in elevation. Fig. 3 is a sectional elevation on the line *x x*, fig. 1 ; and fig. 4 is a similar view on the line *y y*, fig. 1.

"In the practice of my invention the wings 1, formed on opposite sides of the box 2, are supported by adjacent cross-ties 3, the box hanging, as it were, between the ties, as shown in figs.

FIG. 1.

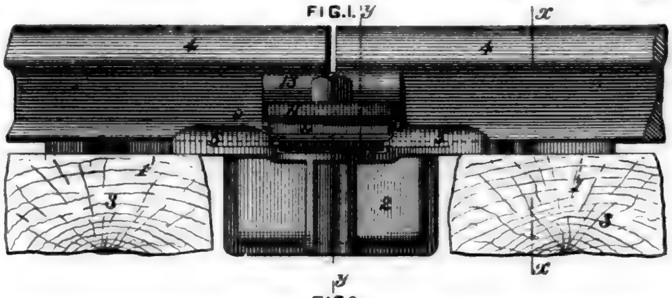


FIG. 2.

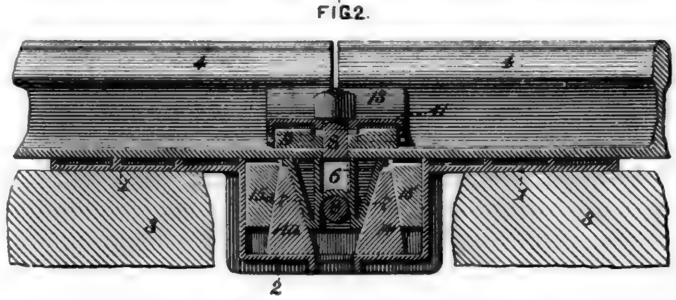


FIG. 3.

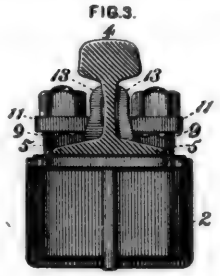
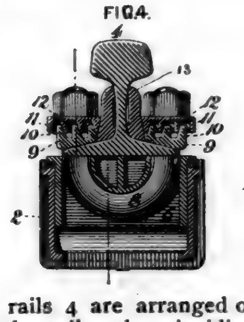


FIG. 4.



1 and 2. The adjacent ends of rails 4 are arranged on the wings 1, the plane of contact of the rail ends coinciding, approximately, with a plane passing transversely through the middle of the box 2, which, as shown in figs. 2 and 4, is open on its upper side, the rails being guided into line with each other by flanges 5, formed on the edges of the wings 1, at or adjacent to the points of junction with the box 2, as shown in figs. 1 and 3, said flanges also serving to strengthen the wings at that point.

"Beneath the ends of the rails is arranged a block 6, having inclined outer faces 7 and a curved seat for the reception of the U-shaped bolt 8, whose threaded ends project up through suitable notches in the flanges of the rails on opposite sides of the web. On top of the rail-flanges I place plates 9, having upwardly-projecting teeth or ribs 10, with inclined inner faces, as shown in fig. 4, and on top of the plates 9, I place plates 11, provided with downwardly-projecting ribs 12, having inclined outer faces, the ribs 12 alternating with the ribs 10. The plates 11 are made of such a width that when the inclined faces of the ribs 10 and 12 partially engage each other, the inner edges of the plates 11 will bear against the splice-bars 13, arranged against the webs of the rails and overlapping the ends thereof, as shown in figs. 1 and 2, and as the plates 11 are pressed down by the nuts on the U-shaped bolts 8, said plates and the splice-bars will be forced tightly against the webs of the rails, holding the latter in perfect alignment. Within box 2 and on opposite sides of the block 6 are placed the oppositely-arranged wedge-blocks 14 15 and 14ª 15ª, as shown in fig. 2, the inner faces of the blocks 14 14ª coinciding as to inclination with the faces 7 of the blocks 6 and the adjacent faces of the blocks 14 15 and 14ª 15ª also coinciding as to inclination, while the outer faces of the blocks 15 15ª are made straight, fitting the sides of the box 2. As shown in fig. 2, the adjusting wedge-blocks 15 15ª, operating by gravity, tend to force the blocks 14 14ª inwardly against the rail-supporting block 6, and also hold said blocks 14 14ª as against any outward movement when operated on by the block 6, the taper of the adjusting-blocks being such as will not render them liable to be raised when pressed upon by the adjustable blocks 14 14ª. It will be observed that the adjusting-blocks 15 15ª operate solely through gravity, the flange of the rails not having any bearing on their ends.

"In adjusting my improved joint to the rails the adjustable blocks 14 14ª are first placed in position, then the supporting-block is arranged between them, and the adjusting-blocks 15 15ª are finally pressed between the sides of the box and the blocks 14 14ª. The rails are then placed and secured in position by the U-shaped bolt, the plates 9 and 11 and splice-bars 13, as hereinbefore described. As a load passes along a rail having its ends supported by my device, the weight will cause a slight depression of the middle portion of the rail and a corresponding elevation of the ends of said rail. As the ends of the rails rise, the block 6 will be lifted up away from the adjustable blocks 14 14ª, which will then be moved inward against the block 6 by the adjusting-blocks 15 15ª, thereby preventing any downward movement or deflection of the rail ends when the load comes upon them. This automatic adjustment of the rail ends will continue until said ends have been raised to a normal level, no further elevation occurring, except such as may be necessary to compensate for the settling of the cross-ties."

Blast Furnaces of the United States.

THE *American Manufacturer* gives its usual monthly table, showing the condition of the blast furnaces on September 1, and says : "In a condensed form the showing is as follows :

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	69	11,769	96	13,228
Anthracite	94	35,497	95	24,438
Bituminous	137	92,915	111	52,719
Total	300	140,181	302	90,385

"As compared with one month ago there has been a marked increase in the total number of furnaces in blast, though not so great a relative increase in capacity.

"As compared with one year ago the position of the furnaces is as follows :

	Sept. 1, 1889.		Sept. 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	69	11,769	68	12,623
Anthracite	94	35,497	98	28,946
Bituminous	137	92,915	132	84,513
Total	300	140,181	298	126,082

"This table shows some considerable changes during the year."

Bridges.

THE Berlin Iron Bridge Company, East Berlin, Conn., has taken a contract for the iron bridge at Fall River, Mass. It will be a deck bridge.

THE Chicago Bridge & Iron Company has been incorporated to make bridges and similar kinds of construction work ; capital, $100,000 ; incorporators, George H. Wheelock, Horace E. Horton, and William B. Wheelock.

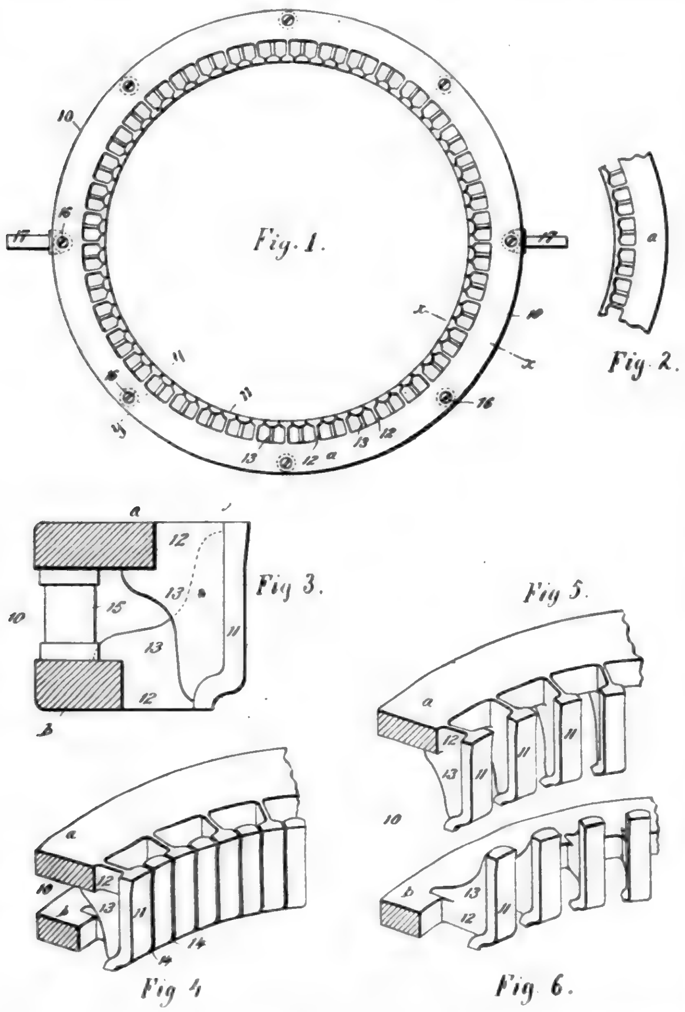
THE R. F. Hawkins Iron Works, Springfield, Mass., have taken a contract for the iron highway bridge over the Acushnet River in New Bedford, Mass. The contract price is $19,000.

THE Schiffler Bridge Company, Pittsburgh, Pa., has taken the contract to build a railroad bridge over the Casey Creek near Nicholasville, Ky. The bridge will be 600 ft. long, and the contract price is $100,000.

THE Phœnix Bridge Company, Phœnixville, Pa., is building two iron bridges of 150 ft. span for the Columbus Southern Railroad in Georgia, and will soon begin work on iron bridges for the Alabama Midland at Montgomery, Ala., and for the Nashville, Chattanooga & St. Louis Railroad over Stone River in Tennessee.

Chill-Mold for Casting Car Wheels.

THE ordinary chill-mold in which car-wheels are cast consists of an iron ring, the inner surface of which forms the mold for the tread of the wheel. The melted iron when it comes in contact with this is cooled suddenly and "chilled," which gives the tread the requisite hardness to resist wear. The difficulty with this form of chill is that the melted iron in coming in contact with it heats and expands it, and that in cooling the iron con-



tracts, and thus the mold and the iron inside of it are drawn away from each other by the expansion and contraction. To get over this difficulty "contracting chill-molds," as they are called, have been devised. These have an outer ring, with projections which are attached to it, and project inward toward the center of the chill, the inner surfaces of these projections forming the tread of the wheel.

The illustrations herewith represent an improved chill-mold of this kind, which has recently been patented by Mr. Ferdinand E. Canda, of New York City. Fig. 1 is a plan, and fig. 3 a vertical section on *a b*, the latter on a larger scale than fig. 1. The chill-mold consists essentially of two or more outer rings, *a b*, fig. 3, and an inner ring 11 made to conform to the tread of the wheel and subdivided into sections that are connected alternately to the outer rings by brackets or webs 13, one end only of each section being connected to its outer supporting-ring, the webs or brackets being formed to properly brace and hold the sections constituting the inner ring. In practice the two or more outer rings would be held apart and spaced by struts or separators 15 that are bolted to place between the rings, and the chill would be made up of an inner compound ring wherein the ring members are divided by vertical or oblique lines of separation. Fig. 4 is a perspective view looking at the inside of a portion of the chill-mold, and in figs. 5 and 6 the two rings are represented as they appear when moved apart. From these it will be seen that the blocks 11, 11 are alternately connected to the auxiliary rings *a* and *b*. In constructing the chill-mold the inventor says he prefers to cast it in one piece, arranging the cores so that they come in proper places, and afterward to divide the sections or blocks forming the inner ring by means of a saw or any other known tool applicable for such work, the saw-kerfs 14 between the sections being about one thirty-second of an inch in width, more or less. Prior to the division just spoken of, he places struts or separators 15 between the auxiliary rings constituting the compound outer ring 10, such struts being held to place by bolts 16, which pass through the auxiliary rings and through the struts or separators: or, if desired, the struts 15 could be cast with the chill and become an integral part thereof. Two of the struts or separators are provided with trunnions 17.

Such a chill as the one above described overcomes the difficulty presented in a chill formed with a solid outer ring, as the expansion of the webs or brackets by which the inner sections are supported will tend to decrease rather than increase the inner peripheral face of the chill, and as the outer ring is divided and exposed to the surrounding atmosphere it will not become unduly heated, as would be the case if it were formed from a solid mass of metal, adequate egress being provided for the heat, gases, and vapors generated in the process of casting the wheel within the chill.

Iron and Steel.

THE Pennsylvania Steel Company some time ago built two new blast furnaces near Baltimore, the object being to have those furnaces at a point where the ore from its mines in Cuba might be readily delivered by ships. Plans have now been prepared for the considerable extension of those works. Besides the blast furnaces, there will be a steel plant with two 15-ton converters; a blooming mill and a rail-mill with a capacity of 1,000 lbs. of steel rails per day. To these the Company expects to add hereafter a steel plate mill and a ship-yard for building iron and steel vessels.

THE Illinois Steel Company has issued a card giving the new names by which their various mills are known. They are: The North Works, at North Chicago; the South Works, at South Chicago; the Union Works, on South Ashland Avenue, Chicago; the Joliet Works, at Joliet, Ill., and the Milwaukee Works, at Milwaukee, Wis. All departments are running to their full capacity.—*Industrial World.*

THE Union Drawn Steel Company, organized last year at Beaver Falls, Pa., is making a specialty of steel shafting for running fine machinery. The Company also manufactures piston-rods, pump-rods, guides, and steel shapes. The Company has an excellent plant, with the building 225 × 50 ft. in size.

THE Edgar Thomson Steel Works have just finished an order for 500 tons of rails, 60 ft. in length. These rails are of unusual weight, 85 lbs. to the yard, and are just double the usual length to which rails are cut.

THE Continental Iron Works, Brooklyn, N. Y., have recently furnished 24 corrugated furnaces for the new Government cruiser *Maine;* 12 for the Morgan Iron Works; 12 for the Quintard Iron Works, N. Y., and a number for other parties. They are also making six corrugated flues, 36 in. diameter and 6 ft. long, for a steamer which is being built by the Dry Dock Engine Works, Detroit, and several flues, 40 in. diameter and 18 ft. long, for the boilers of the Duluth Electric Light station.

THE stockholders of the Thomas Iron Company, at Hokendauqua, Pa., have authorized the directors to complete the agreement for the sale of the works to English parties, who, it is understood, are the same who recently bought the Otis Steel Works at Cleveland.

Marine Engineering.

THE Pusey & Jones Company, Wilmington, Del., is building two stern-wheel steamboats to run on the Indian River in Florida. One of these boats will be 130 ft. long, 24 ft. wide, and 4 ft. deep, with compound engine having cylinders 14 in. and 30 in. diameter, and 60 in. stroke. The other boat will be 110 ft. long, 28 ft. wide, and 4 ft. deep, with a compound engine having cylinders 11 in. and 24 in. diameter and 48 in. stroke. These boats will draw only 18 in. of water when loaded.

Locomotives.

THE Pennsylvania Company's shops at Fort Wayne, Ind., are building 11 consolidation locomotives of class S for the road.

THE Rogers Locomotive Works, Paterson, N. J., are building six engines for the Sioux City & Northern Railroad.

THE Pennsylvania shops at Altoona, Pa., are building 17 very heavy passenger locomotives for use on the New Jersey divisions.

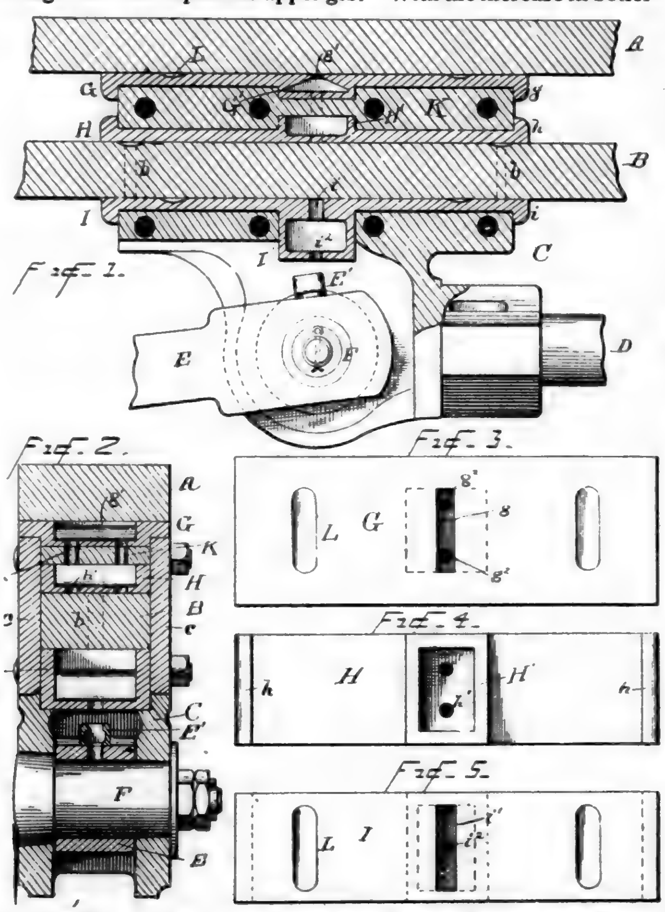
ALL the machinery in the Hinkley Locomotive Works in Boston has been sold. About two-thirds of it was sold at private sale, and the remainder at auction. The property occupied by the works has also been sold and will be used for the electric plant for the West End Railroad Company.

THE Portland Company, at Portland, Me., has resolved to continue the manufacture of locomotives in spite of reports which had been circulated to the effect that the business was to be given up. Some changes are to be made with the view of cutting down the expenses as much as possible. Besides locomotive work, the shops are doing a good deal of marine engine and repair work.

Improved Cross-Head.

MR. LOWELL H. KENYON, of Alleghany, Pa., has patented a cross-head, which is illustrated by the engravings herewith. He describes his invention as follows in his specification :

" In a locomotive which runs for the most part in a forward direction the effect of the inclination of the connecting-rod is to cause the cross-head to press upward, when propelled by steam, when making either the forward or the backward stroke. This brings the wear upon the upper gib. With the increase in boiler-



pressures and the larger cylinders now coming into use, the pressure on the cross-head gibs is becoming much greater than heretofore, and consequently it is necessary to provide a larger wearing-surface to keep the friction down to the proper limit and prevent excessive wear and heating. A better mode of oiling the gibs and guides is also desirable. Both of these objects I have aimed to accomplish in my improved cross-head.

" I make use of the ordinary two-bar guide, and provide the cross-head with the usual gibs, one bearing against the under side of the upper bar, and the other bearing on top of the lower bar. I add to these another gib bearing against the under side of the lower guide-bar. This gives the cross-head three gibs, the top and bottom ones bearing against the under sides of their respective guide-bars and the middle one resting on top of the lower guide-bar. The top and bottom gibs, however, sustain the thrust of the connecting-rod, and as their combined bearing-surfaces are nearly double the area of the single gib ordinarily used, it is evident that the wear per square inch is reduced by nearly one-half and the friction is similarly greatly lessened. I also provide the gibs and guides with oil-holes and chambers, whereby the oil is more evenly distributed, is fed from the top gib through to the bottom gib and thence to the cross-head pin, and the guides are kept oiled when the engine is at rest.

" In the drawings, fig. 1 is a vertical longitudinal section of a two-bar guide and a cross-head embodying my improvements. Fig. 2 is a cross-section thereof through the cross-head pin, and the other figures are detail views of the gibs."

Cars.

THE St. Charles Car Company, St. Charles, Mo., is building 30 passenger cars for the Rio Grande Western Railroad.

THE Pullman Car Works, Pullman, Ill , have orders on hand for about 1,000 freight cars, including a large number of box cars for the Georgia Pacific Railroad.

THE Wells & French Company, of Chicago, are building 500 box stock and coal cars for the Rio Grande Western Railroad.

THE Erie Car Works, Erie, Pa., are building 100 coal cars for a New England road, 100 for the Rainey Bank Coal Company, and 300 for the Pennsylvania Railroad.

THE Pennsylvania Company's shops at Fort Wayne, Ind., are building 100 refrigerator cars for the Pittsburgh, Cincinnati & St. Louis Railroad. These cars are of the same pattern as 100 completed for that line a short time ago.

THE Minnesota Iron Car Company has been incorporated successor of the Minnesota Car Company. The incorporators are John F. T. Anderson, W. E. Tanner, and Joseph R. Anderson, of Richmond, Va., and George W. Ettinger, of New York. Its capital will be $2,000,000.

Some New Railroad Shops.

THE Long Island Railroad Company is building new shops near Jamaica, N. Y., to take the place of the old repair shops at Hunter's Point, which are now too small for the needs of the road. The new buildings are of brick, with granite foundations and trimmings. They consist of two large main structures, running north and south, respectively 547 × 85 ft. and 420 × 100 ft. ; a blacksmith shop 100 × 60 ft. ; a boiler-house 35 × 45 ft. ; an engine-room 26 × 45 ft., and a store and pattern-room, all separate from each other, and a chimney or smoke-stack between the boiler-house and blacksmith shop 125 ft. high and 16 ft. in diameter at the base.

While the new works will not be the largest in the country, they will be among the most complete in design and appointments. The total cost will be about $175,000. The contract for building them was given to the Flynt Building & Construction Company, of Palmer, Mass. The architect was L. H. Gager, of Palmer, Mass., and the Company's Chief Engineer, Anthony Jones, had charge of the work. The immediate supervision, however, of the details in the construction of the new buildings and fitting them up, was intrusted to Charles A. Thompson, Master Mechanic of the Long Island Railroad.

The big building is divided into three : A paint shop 239 ft. long, containing 14 tracks running across the building, so that 14 cars can be worked upon at once ; a car-building shop 214 ft. long, with 13 tracks, and a mill-room 89 ft. long, where the lumber will be planed and prepared. These three shops are the full width of the building—85 ft. The building is 30 ft. high inside to the center of the roof. The flooring consists of a combined Trinidad and Neufchâtel asphalt pavement.

The machine shop, 420 ft. long by 60 ft. wide, with an annex 40 ft. wide running the entire length, in which is placed the various machinery, contains 16 tracks and pits. The building has a truss roof, and is well lighted. It is fitted with two traveling cranes of a joint capacity of 50 tons, which combined can pick up an engine and transfer it easily over other engines in the building from one part of the shop to another. The cranes are laid on the trusses and sustained at both ends ; they were built by the Morgan Engineering Company, Alliance, O.

The smiths' shop will contain a large furnace, two steam-hammers, each having a head weighing 1,200 lbs., and 13 forges. It is unusually well lighted and ventilated.

Power for the shops is furnished by three Westinghouse compound automatic engines of 225 H. P. The boilers are built by the Bigelow Company, New Haven, Conn.

In addition to the tools transferred from the old shops, these shops will have a number of new tools, including cylinder-boring

machines, driving-wheel lathes, planes, etc., the contract for which was taken by Manning, Maxwell & Moore, New York.

Between the two main buildings will be an immense transfer-table 78 ft. long, for the purpose of transferring engines and cars in and out of the shops. It will rest on eight tracks and is being made by the Yale & Towne Manufacturing Company.

In addition to the buildings mentioned, there will be a round-house 300 ft. in diameter, with stalls for 50 locomotives.

OBITUARY.

CAPTAIN JAMES REES, the celebrated boat-builder, died at Pittsburgh, Pa., September 12, aged 69 years, of asthma, after a prolonged illness. Captain Rees was the first manufacturer to make a steel-plate river boat.

JAMES H. MORLEY, of St. Louis, a well-known civil engineer, died September 12, at Windsor, N. Y., after a long illness. He was 65 years old, and was born in New York. He was Chief Engineer of the Missouri Pacific Railroad.

WILLIAM H. CILLEY, the associate of Henry Meiggs in the construction of the celebrated Lima & Oroya Railroad, died September 10 at Lima, Peru. Leading residents of Lima and the School of Engineers attended the funeral, and a great number of business houses were closed as a mark of respect.

JOHN COFFIN, Chief Engineer of the Johnson Company, of Johnstown, Pa., died in that place September 3. Mr. Coffin was born at Chatham, N. Y., on September 18, 1856. He studied engineering at Cornell University, and subsequently took charge of a machine-shop at Syracuse, N. Y. In 1881 he located at Johnstown, securing a position in the drafting d -partment of the Cambria Iron Works, and later entered the service of the Johnson Company.

PROFESSOR GEORGE H. COOK, who died suddenly at his home in New Brunswick, N. J., September 22, was born in Hanover, N. J. About 1836 he began work as a civil engineer, and was employed to lay out the line for the old Catskill & Canajoharie Railroad. He was not, however, satisfied with his attainments, and entered the Rensselaer Polytechnic Institute, graduating in 1839. He afterward became a teacher in the Institute, and in 1842 was made Senior Professor, a position equivalent to the Presidency. He afterward became Professor of Mathematics and Natural Philosophy in the Albany Academy. In 1850 he became Principal of the Academy, and held the office two years, leaving on his election to the Chair of Chemistry and Natural Philosophy in Rutgers College. The next year he was made Assistant Geologist of New Jersey.

The office of State Geologist had been allowed to lapse for several years, but a paper by Dr. Cook led to its reorganization, and in 1864 he was made its head. His work as State Geologist has been varied and of great importance. The topographical maps of the State which have been published under his supervision have been adjudged the best of any published by the different States. The last of the series was recently issued, and Dr. Cook was at the time of his death engaged on his final report. Two volumes had been prepared, the latter now being in print.

In 1864 the State Agricultural College was attached to Rutgers, and Dr. Cook, while retaining his professorship, became Vice-President of the college. He was the organizer of the State Board of Agriculture, and having been for a long time its Secretary, became in 1886 Chief Director of the New Jersey State Weather Service. He was long President of New Brunswick's Board of Water Commissioners, was a member of the State Board of Health, and held many minor offices in the State. He had been active also in work elsewhere. In 1852 he was sent to Europe by the State of New York to make investigations that might aid in developing the Onondaga salt springs. He went again to Europe in 1870 to study certain geological subjects, and in 1878 was a delegate to the International Geological Congress held at Paris in connection with the French Exposition.

Dr. Cook was a member of the American Association for the Advancement of Science and the author of many papers and addresses. He received the degree of Ph.D. from the University of New York and of LL.D. from Union College. He was a most unostentatious man, very plain in address, but a persistent worker and an indefatigable collector, as the State Museum at Rutgers bear witness. He leaves a widow and two children, one son and one daughter.

PERSONALS.

E. T. JEFFREY has resigned his position as General Manager of the Illinois Central Railroad.

JAMES G. DAGRON has been appointed Engineer of Bridges of the Baltimore & Ohio Railroad.

COLONEL WILLIAM F. SWITZLER has resigned his position as Chief of the Bureau of Statistics in the Treasury Department.

A. P. GEST, late Assistant Engineer New York Division, Pennsylvania Railroad, has been appointed Superintendent of the Bedford Division.

WILLIAM MAHL has been appointed Assistant to the First Vice-President of the Southern Pacific Company, with office at No. 23 Broad Street, New York.

WHEELOCK G. VEAZEY, of Vermont, has been appointed a member of the Interstate Commerce Commission, to succeed A. F. WALKER, resigned. Mr. Veazey is a lawyer and judge of good standing, and a competent and able man.

M. S. BELKNAP, it is reported, has resigned the office of General Manager of the Central Railroad of Georgia, to accept a position in Mexico. It is said that he will be succeeded on the Central by CECIL GABBETT, now General Manager of the Western Railroad of Alabama.

CHARLES BLACKWELL has been appointed Assistant Superintendent of the Toledo, St. Louis & Kansas City Railroad, with general supervision of the mechanical department and train service. Mr. Blackwell has had extensive experience in the locomotive department, and is exceedingly well qualified for the position.

ALLEN MANVEL has been chosen President of the Atchison, Topeka & Santa Fé Railroad Company. He has been Superintendent of the Chicago, Rock Island & Pacific, Superintendent and General Manager of the St. Paul, Minneapolis & Manitoba, and is well qualified for the somewhat difficult position he has assumed.

JOHN H. JONES and DR. CHARLES A. ASHBURNER have been appointed special agents to collect the statistics of coal for the Eleventh Census ; JAMES M. SWANK, of Philadelphia, to collect the statistics of iron and steel ; JAMES H. BLODGETT, of Rockford, Ill., to collect the statistics of education, and JOSEPH D. WEEKS, of Pittsburgh, to collect the statistics of petroleum, coke, natural gas, and glass.

WILLIAM B. STRONG has resigned his position as President of the Atchison, Topeka & Santa Fé Railroad. Few railroad men have had a more varied experience than Mr. Strong, who has held almost every position from telegraph operator up to General Manager and President, and has served on the Milwaukee & St. Paul, the Chicago & Northwestern, the Chicago, Burlington & Quincy, the Michigan Central, and the Atchison, Topeka & Santa Fé.

HORACE SEE has resigned his position as Superintendent Engineer of the William Cramp & Sons Ship & Engine Building Company in Philadelphia. Mr. See is at present taking a trip in Europe ; on his return in the latter part of October, he will establish an office in New York as Consulting Engineer. Mr. See has a high reputation as a marine engineer, and has designed the engines of many notable ships. His removal to New York will be an additional insurance of the pre-eminence of New York as a center of marine engineering.

PROCEEDINGS OF SOCIETIES.

American Association for the Advancement of Science.—The annual meeting was held in Toronto, Ont., beginning August 28 and ending September 3. Some 200 new members were elected.

Among the papers read in the Section of Mechanical Science and Engineering were : Preservation of Timber, by O. Chanute ; Air Compressors, by J. E. Denton ; Long Span Bridges, by Gustav Lindenthal ; Pumps and Injectors, by E. B. Perry.

A very interesting paper by J. Richards Dodge treated the question of Irrigation at considerable length.

The following officers for the ensuing year were elected : President, George L. Goodall, Cambridge, Mass. ; Vice-Presidents, S. C. Chandler, Cambridge, Mass., mathematics and astronomy ; Cleveland Abbe, Washington, physics ; R. B. Warder, Washington, chemistry ; James E. Denton, Hoboken,

N. J., mathematical science and engineering; John S. Brauner, Little Rock, Ark., geology and geography; C. S. Minot, Boston, biology; Frank Baker, Washington, anthropology; J. R. Dodge, Washington, economic science and statistics. Permanent Secretary, F. W. Putnam, Cambridge, Mass. General Secretary, H. C. Bolton, New York. Secretary of Council, James Landon, Toronto. Treasurer, William Tilly, Mauch Chunk, Pa.

The Association will meet next year at Indianapolis on the third Wednesday in August.

Association of North American Railroad Superintendents.—The Eighteenth Meeting will be held at the Hotel Brunswick, New York City, October 7 next, at 11 A.M.

Matters of importance to come up at this meeting are the relations of the Association to the General Time Convention; its relations to other organizations of railroad men, and the adoption of an amended constitution.

The Committee on Roadway will report on Rail Sections, and also on the award of the prize for the best treatise on Trackwork; the Committee on Machinery will report on Steam Heating of Trains and on Train Signal Apparatus; the Committee on Transportation will report on Uniform Forms for Time-tables and on Methods of Discipline.

All railroad superintendents are invited to attend the meeting and to join the Association.

Roadmasters' Association of America.—The annual convention began at Denver, Col., September 11, with a very good attendance.

The leading subject of discussion was rail-joints, on which papers were presented by Messrs. Burnett, Delano, and others.

Reports were also presented and discussions had on Frogs; Track Labor; Switch-stands, and Protection of Facing Points; Track Tools; and on Cattle-guards.

It was decided to hold the next convention in Detroit.

The following officers were chosen for the ensuing year: President, John Sloane; Vice-Presidents, W. H. Courtney, John Doyle; Secretary and Treasurer, John C. Ramsey; Member of Executive Committee, George E. Cain. The address of the Secretary is Connersville, Ind.

American Institute of Mining Engineers.—The 55th meeting of the Institute begins at Ottawa, Canada, October 1, continuing throughout the week. The programme includes business meetings for the reading of papers on Tuesday, Thursday, and Friday; excursions to the Phosphate Mines near Ottawa, to the Copper Mines at Sudbury, and other points of interest in the neighborhood. Those members who desire to do so will be taken from the Canadian Pacific Railroad to Port Arthur and the Silver Mines on the north shore of Lake Superior.

New England Road-Masters' Association.—The seventh annual Convention began in Boston, August 21, and continued for three days. Reports were presented by the Committees on Track Repairs; on Cattle-guards and on Fences—all of which called out much discussion, especially that of the Committee on Cattle-guards.

It was decided to hold the next Convention in Boston. The following officers were elected for the ensuing year: President, G. W. Bishop; Vice-President, W. E. Clark; Chaplain, J. S. Lane; Secretary and Treasurer, W. F. Ellis.

Master Car & Locomotive Painters' Association.—The 20th annual Convention began in Chicago, September 11. The reports show an increase in members, there being now 132 active members. Papers were read on Painting the Heating Parts of Locomotives; on Painting the Inside of Passenger Cars; on the Use of Varnish on Cars; on Decorating Cars and Locomotives, and on the Time which the Locomotive should run before being repainted. All these papers were discussed by the members present, and on several of them, letters and reports were received from absent members.

It was decided to hold the Convention next year in Boston. The following officers were elected for the ensuing year: A. E. Barker, President; William Lewis and E. G. Fetting, Vice-Presidents; Robert McKeon, Secretary and Treasurer.

American Society of Civil Engineers.—A regular meeting was held in New York, September 4. A paper by John F. Wallace on the Sibley Bridge was read.

H. C. Miller gave an account of his experiences in Nicaragua, and of the work done on the surveys of the canal.

The tellers announced the following elections: *Member*, Bushrod W. Taylor, Louisville, Ky.; *Junior*, Mario Lorini, New York.

Engineers' Club of St. Louis.—At the regular meeting, September 11, a letter from the Committee of the American Society of Civil Engineers on revision of the constitution was read. The Executive Committee presented a report recommending the appointment of the Committee to consult with the Committee of the American Society and with other clubs on the plan of union, on the following basis: All local clubs to become chapters of the American Society and to be recognized as such; conditions of membership to be settled by conference. The report was accepted and it was ordered that the Committee be appointed as recommended, and the President appointed as such Committee Messrs. R. E. McMath, J. A. Seddon, and Robert Moore.

Engineers' Club of Kansas City.—The programme for the meetings of this Club for the present season includes the reading and discussion of the following papers:

October 7, Tests and Observations on Building Stones, by J. A. L. Waddell and W. D. Jenkins.

November 4, general discussion on Sewerage Systems.

December 2, Snow Plows, by F. E. Sickels.

December 4, Annual Meeting of the Club.

September 7, a regular meeting was held at Wallula, Kan., by invitation of Mr. H. A. Keefer. It was voted to appoint a committee to confer with a committee of the American Society of Civil Engineers, and similar local committees with reference to a closer affiliation among the various engineering societies. Resolutions of respect to E. J. Remillon, a member lately deceased, were passed.

Papers were ready by A. G. Glasgow on Water Gas, and by H. A. Keefer, on the Early Manufacture of Iron.

After a brief discussion of the papers, the Club was entertained at lunch by Mr. and Mrs. Keefer.

New England Railroad Club.—The September meeting of this Club consisted of a dinner and reception, which was held September 11 at the United States Hotel in Boston. A large number of members of the Club and invited guests were present, most of them accompanied by ladies. After the dinner a number of speeches were made.

NOTES AND NEWS.

A New Naval Dry-Dock.—The great new dry-dock at the Norfolk Navy Yard was opened September 19, the steamer *Yantic* being the first vessel docked.

The new dock is 530 ft. over all, and will take a vessel of 430 ft. in length of keel, 26 ft. 6 in. draft, and in width will take anything now afloat. The depth of water at the entrance to the dock at high water will be 26 ft. 6 in., and at low water will be 23 ft. 8 in., the rise and fall of the tide at the Navy Yard being 2 ft. 10 in. The average depth of the Southern Branch of the Elizabeth River, which forms the approach to the new dock, is about 35 ft. at high water, and this will allow the largest ships of the Navy to come up at any time. The site of the dock, which is near the southern end of the yard, was chosen on account of the width of the river at the point, and its close proximity to the various shops of the yard. The axis of the dock lies about northwest by southeast, and it is protected on three sides from heavy gales, which makes it possible to dock a vessel in the roughest weather. The dock when full holds about 8,000,000 gallons of water, and at the official inspection of the dock it was emptied in the short time of 1 hour 5 minutes 26 seconds. The pumps are two in number, and of the centrifugal order, built by the Southwark Foundry & Machine Company of Philadelphia. They have an average capacity each of about 52,000 gallons per minute. The contract for the building of the dock specified that these pumps should have a capacity of 40,000 gallons, but the test shows them to be largely above this figure.

The foundation of the dock is piling, over which, to the depth of 3 ft., is a solid bed of concrete. Above the concrete floor the dock is of wood, and 1,000,000 ft. of Georgia heart pine and almost as much other timber was used in its construction. Where any of the timber is exposed to the salt water it was creosoted to prevent it from the destroying attacks of the toredo worm. The caisson which closes the mouth of the dock is an

iron structure ribbed and riveted, and is worked with water ballast. There are eight feeding valves and culverts through it, and by them the dock has by actual test been flooded to a depth of 25 ft. in 55 minutes. All of the bilge blocks are operated from the top of the dock. The sides of the dock, which are constructed with steps which have 8 in. rise and 10 in. tread, makes shoring easy.

This dock was built for the Government by J. E. Simpson & Company ; its total cost was about $495,700, and the time occupied in building it was 22 months.

Collapse of a Locomotive Water Tank.—The *Zeitschrift der Lokomotivführer* records the collapse of a locomotive water tank, which is noteworthy in several respects. The tanks were located at both sides of the boiler, measured about 18 ft. by 2½ ft., by 1½ ft., and held, together, about 123 cubic feet. They were connected by a 4-in. pipe, and the water level was shown by a float and suitable index. The walls of the tank were stiffened by angle irons and flat braces riveted to the inside. The engine, having just come in from a run, was to be housed, and as the tanks were nearly empty a water-supply pipe was coupled on, and the right-hand tank filled. The right-hand injector was still feeding while steam from the boiler, which was at a pressure of about two atmospheres, was being blown into the left-hand tank. This lasted about three minutes, when suddenly this tank collapsed with a loud noise similar to that produced by a hammer-blow against an empty tank. The force of the collapse was such as to bend or break all the angles and to bend the braces to one side. The tank-plates above and below the angle irons were torn and the top and bottom plates forced outward. One of several plates, about 7 in. wide and 0.7 in. thick, by means of which the tank was bolted to the engine frame, was wholly broken off. The extent of the damage points to the fact that the partial vacuum produced by the inflow of steam to the tank must have been considerable, and can be explained by the circumstance that an appreciable quantity of cold water overflowed from the right-hand tank, which had become full, into the one on the left, in which there was only a small quantity of water, not sufficient to condense the steam in it. The covers on the tanks were practically air-tight, having become battered down by the constant concussion while on the road, and being furthermore held in place by springs. Entrance of air was, therefore, impossible, there being no special provision for this, as in the engines of more recent build.

Electric Light for a Penny.—One of the latest novelties in the application of electricity has recently been fitted to the cars of an English railway line. The apparatus is conveniently placed just above the head of the passenger and is contained in a small box about 5 in. long and 3 in. wide, in which is a five-candle-power light. To obtain the desired illumination a penny is dropped in a slot in the top of the box, and by a subsequent pressure of a knob the current is turned on, giving a light that will last half an hour, at the end of which it is automatically extinguished.

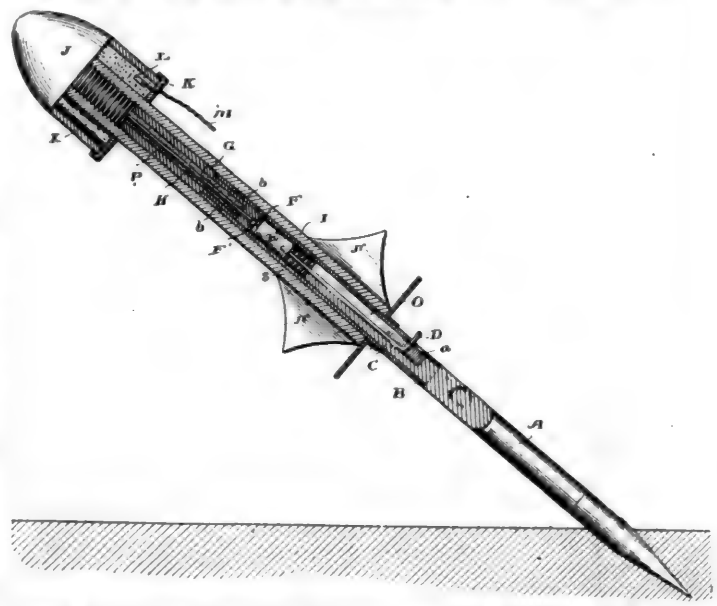
A second push-button affords a means of putting out the light at the will of the passenger. Should the light be desired for a longer time than half an hour, a penny dropped in at the end of that interval will suffice. Should the instrument be out of order the penny drops right through and comes out at the bottom of the box, so that it can be recovered, and the same result happens in the case of any coin other than a penny. Each carriage is fitted with an accumulator for supplying the electricity. The invention has been found to add greatly to the comfort of passengers, and is very much superior to the lamp formerly in use, screens being supplied to prevent the light interfering with those who do not care to use it.

Indian Railroad Accidents.—At the end of the last quarter of 1888 there were 14,456 miles of railroad open in this country, and the total number of passengers killed was only 13, and of those injured 45 in a train mileage run of 12,588,692 miles. In addition to the above, 47 servants of the companies were killed, and 151 injured, while of others, such as trespassers and suicides, there were 60 killed and 26 injured. Besides these, 11 persons were killed and 44 injured in yards, workshops, etc., and 138 persons died in the carriages or at stations from causes unconnected with the working of trains. These figures naturally show an increase over the average of the same quarter for the previous five years, but if the extra number of miles of lines open are taken into consideration, both the number of fatal accidents and of injuries were less in proportion. There was a large increase in the number of accidents on the Bengal-Nagpur, the Oudh & Rohilkund, the Southern Mahratta and the Nizam's railroads, while there was a decrease on the Northwestern, the Eastern Bengal, and the Great Indian Peninsula Railroads. The worst accident occurred on the Tirhoot State Railroad, owing to a collision between a mixed train and some wagons on the Motihari goods shed line, in which three coolies were killed on the spot, and four seriously injured. This accident was due to the carelessness of the station staff, some of whom were prosecuted and imprisoned.—*Indian Engineer*.

The Emmens Torpedo Gun.—The accompanying illustration shows a torpedo and torpedo gun, which is the subject of United States patent No. 409,943, recently granted to Stephen H. Emmens, of London, England. The device is thus described by the inventor :

" The figure represents an elevation of a torpedo-gun and a bird-torpedo, partly in longitudinal section, illustrating this invention.

" The firing mechanism, which especially distinguishes the present weapon, comprises a wooden stock *A*, fitting into and supporting a metallic tube *B*, and axially perforated and slotted at its front end to accommodate within said tube a rod *C*, which is bent at right angles at its rear end to form a trigger *D*, that projects outward through a bayonet-joint slot *a* in the stock *A* and tube *B*. The front end of said rod *C* is fixed in a piston *E*, which carries a firing-pin *F*, and between said piston and the front end of the stock *A* is a spiral spring *s* ; hence, when the

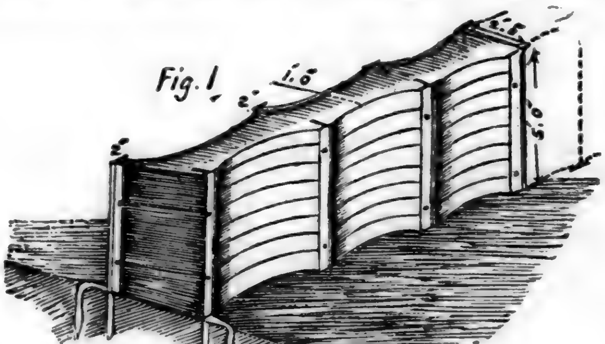


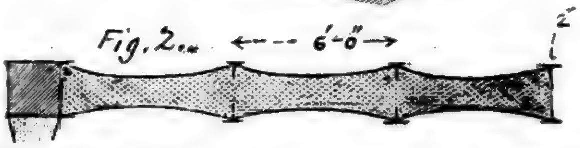
trigger *D* is pulled back and turned into the holding-notch of the bayonet-joint slot *a* said spring *s* is compressed, and when the trigger is released the spring urges forward the piston *E*, with its firing-pin *F* to explode the propelling-charge *P*. This is contained within a short gun-cartridge shell or powder-tube *G*, which fits into the front end of said tube *B* and is coupled thereto by a pair of bayonet-joints *b*. Preferably the powder-tube, as it is hereinafter termed, is provided with a primer-recess *F'* in its breech end and with an axial ignition-tube *H*, extending forward from said primer-recess to the front of the propelling charge. The latter may be of any suitable explosive. The ignition-tube is filled with gunpowder, and the recess *F'* is provided with a suitable percussion primer. When the latter is exploded by the firing-pin *F*, a sheet of flame is produced within the tube *H*, which ignites the propelling-charge *P* at its front end, so as to insure its perfect combustion and an effective discharge of the weapon.

" The bird-torpedo comprises a tube *I* fitting closely over said tubes *G* and *B* and plugged at its forward end by the screw-stem of a conoidal torpedo-head *J*. In an external annular charge-space immediately behind the head and around said tube *I* cartridges of emmensite or other high explosive are arranged side by side to form the high-explosive charge *X*. By using cartridges of different lengths the size of the high-explosive charge may be varied to any required extent. These cartridges are held in position by a collar *K* and a cylindrical jacket *L*, and they are fired by a time-fuse *M*. The rear end of the torpedo-tube *I* is provided with three equidistant wings *N*. An annular screen *O* is fitted to the tube *B* immediately in front of the trigger *D*, to protect the hand of the person discharging the weapon from any escape of heated gases between said tubes *B* and *I*.

" The figure shows the weapon planted in the ground for firing ; but it will be understood that any other mode of mounting may be employed—as, for example, the stock may be clamped in a holding-tube on an ordinary swivel-stand or gunwale attachment."

A Novel Wall.—Having been called on for a design for a parapet wall to be built to enclose a garden in a large bastion of the old fort in Bheer, Hyderabad, Deccan, the following design suggested itself to meet the conditions of the case: The bastion wall is about 70 ft. in height; some 10 or 15 ft. of the upper portion having fallen down, it was repaired in a "kutcha" manner, so that it was untrustworthy to build on, and as the rampart, forming a fine evening promenade for the Taluqdar and his officials of an evening, could not well be encroached on, it became necessary to build something on the very edge. A wire railing in such a position was not considered suited to the case, so the following was designed: At intervals of nearly 6 ft., upright standards of T-iron, with heads of the T's outward are fixed by pronged feet into the ground at 2 ft. apart in pairs, the gauge being maintained by ties, as shown in sketches. Corrugated sheet-iron is then sprung in between the T standards, and the interior space filled with rammed earth. The top of the wall is planted with creepers or flowers, along which a rill of water flows in a split bamboo. The applications of this principle are numerous, such as revetting the banks of canals,



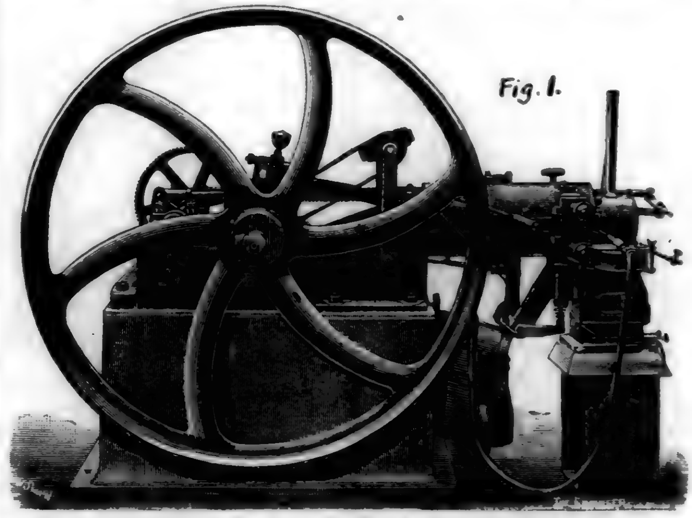


making piers of bridges, lofty signal towers or pillars for elevating wire ropes for crossing ferry-boats over streams, in which case the pillars can be filled with sand.—*Indian Engineering.*

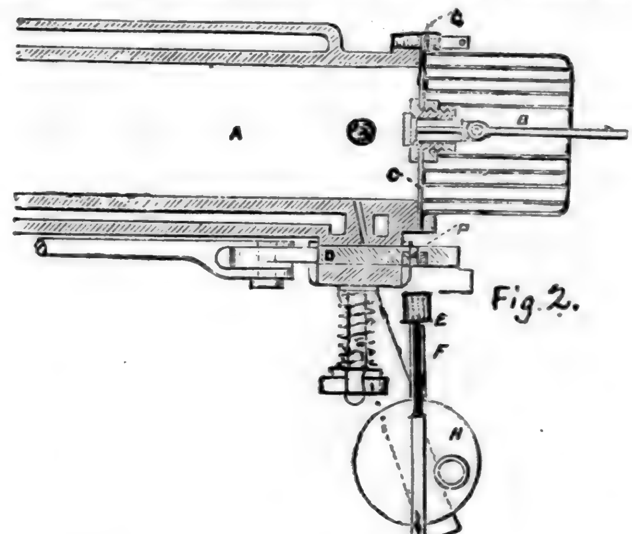
The Knight Petroleum Engine.—The accompanying engravings show a new oil engine invented by J. H. Knight, of Barfield, Farnham, England. It is a horizontal engine, burning the vapor of paraffine oil in the cylinder. The $\frac{1}{2}$ H. P. shown in the engraving has a 4-in. cylinder and an 8-in. stroke. The vaporizing chamber is at the end of the cylinder, which is closed by a steel plate about $\frac{1}{2}$ in. thick, and to which are attached plates somewhat like the ribs of a Gurney's stove projecting into the vaporizing chamber. The latter and part of the cylinder and lighting slide are shown in the sectional view, fig. 2. In this *A* is the cylinder; *B* the vaporizer; *C* the steel plate closing the cylinder, to which are fixed the copper radiating plates; *D* the slide containing the wire; *P* the platinum wire; *E* the lamp; *F* the blow-pipe, and *H* the lamp-container.

Under the vaporizing chamber is a paraffine heating stove for preliminary heating. This heats the chamber to a considerable temperature, and when it is hot enough, which is in 10 to 15 minutes, a small quantity of oil is pumped into the chamber by a small pump—not shown in the engraving. Some of this is immediately vaporized, and on the fly-wheel being turned by hand it is sucked into the cylinder, fired, and motion given to the moving parts. The air and oil enter together by the vertical pipe at the after end of the engine. The heating lamp is extinguished when the engine has got well to work. Vapor of paraffine oil is more difficult to ignite than gas or bensoline vapor. The igniting slide, which is of very small dimensions, contains in a hole a spiral of platinum wire. This is exposed to the flame of a paraffine oil lamp, a high temperature flame of the blow-pipe kind, the air blast for which is made by the bellows fixed on the after end of the bed-plate under the cylinder. At the proper moment, the platinum wire, which is kept at a white heat, is by the motion of a cam drawn into communication with the compressed charge of vapor and air. The slide, although intermittently exposed at one end to the heat of the blow-pipe, wears remarkably well. In one engine, which has been in daily use for a year and a half, the slide has not been refaced or scraped up during that time. The soot and oil vapor appear to act as an excellent lubricant. The oil is pumped into the chamber by a diminutive force-pump worked by the engine. It is on the right-hand side of the cylinder.

The engine is on the three-cycle system, the same as the Griffin and Beck gas engines. The great advantage of this system for oil engines is, that as the exhaust is completely cleared away from the cylinder the charge of vapor and oil is more readily ignited. The governor acts in a twofold manner, first by stopping the supply of oil to the vaporizing chamber,



and by preventing the valve connecting the cylinder and vaporizing chamber from opening, so that an explosion is missed. The cylinder is water-jacketed, the water circulating as in gas engines. No oil is required in the cylinder; a small quantity of the vapor condenses at each stroke and acts as a lubricant. The slide requires a small quantity of oil. The $\frac{1}{2}$ H. P. engine runs 30 revolutions per minute, and gives 0.8 to 0.95 H. P. on the brake, according to the quality of oil used. If a suitable oil is



used, a brake horse-power requires, we are informed, one-fifth of a gallon of oil per hour. The igniting lamp burns about a pint and a half in the day. The oil used is ordinary paraffine or kerosene oil, such as is used in all parts of the world for illuminating purposes, and which does not give off an inflammable vapor at a low temperature.—*London Engineer.*

Petroleum in Beluchistan.—The Kattan Petroleum Works have now passed beyond the experimental stage. An agreement has been definitely entered into to supply for the works at the Khojak Tunnel about 3,250,000 gallons of the oil. The wells, which are 42 miles from the railway, have been connected with Babar Kuch on the Sind-Peshin line by an excellent road. The water supply has been seen to, and house accommodation is increasing. The saving to the State from the use of the petroleum on the Khojak works alone will, it is estimated, be enough to cover all the cost of the Kattan experiments and leave a balance. There is no reason to anticipate that the benefits of the apparently inexhaustible supply should end here. In a country like Beluchistan, where every stick of wood is worth its weight in silver, the demand for the new fuel must be great,

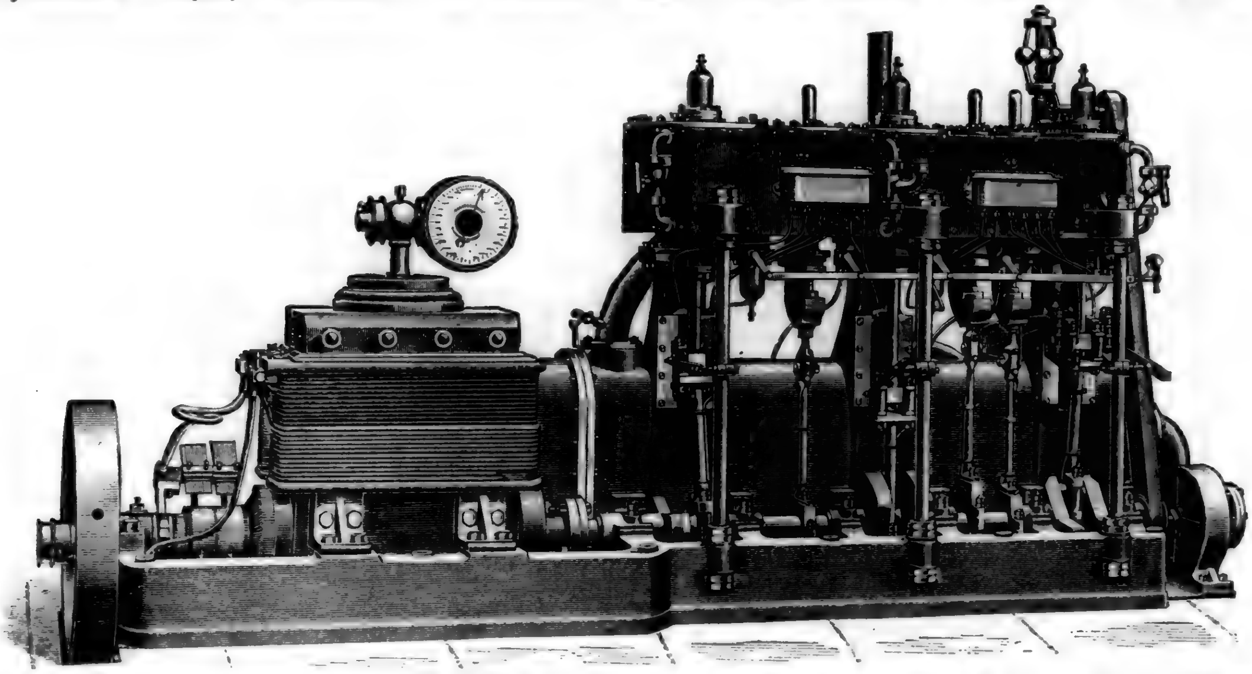
and the destruction of the forests, which recently was going on at an alarming rate, will be put a stop to. It is intended to replace the expensive and wasteful method of camel carriage by a pipe-line from the wells along the Babar Kuch road, which will fully develop the new industry.

Electric-Light Installation on the Armor-clad Cruiser "Admiral Nakimoff."—This is the first Russian armor-clad lighted throughout by electricity. The installation was set up by the Jablochkoff Company, and consists of four compound-wound Gramme dynamos, designed for an output each of 140 ampères at 65 volts, driven by four separate engines, and feeding 320 glow-lamps and two Mangin search-lights, placed at the ends of the fore-bridges. The two dynamos for feeding the search-lights are placed amidships on the gun-deck, and the other two, for lighting the decks, are placed amidships on the main-deck. The engines working each pair of dynamos are connected by separate steam-pipes to both the main and auxiliary boilers. Each dynamo can be switched on to any circuit at will, and each pair of dynamos can be connected in parallel arc. The switching of any dynamo on to the deck or search-lights is done by means of two three-way commutators attached to each dynamo.

The construction of the cruiser is as follows: Above the protected deck, along the whole length of the vessel, extend the gun and main-decks, and under the protected deck, in the central part of the vessel, are placed the engines, and in the bows and stern the ammunition magazines and provision-stores. The conducting-mains form three closed double circuits, all connected to the main switchboard. Two of these double circuits supply the gun and main-decks, one pair extending along the port side of the gun-deck, descending at the bows to the main-deck, thence led aft along the whole length of the port side of the main-deck, and ascending at the stern to the gun-deck, where the respective conductors join, and thus form each a complete circuit. The second pair of conductors travel along a parallel path, but on the starboard side of the vessel. The third pair of conductors supply the engine-rooms, stoke-holes, and magazines. Owing to the uneven distribution of the lamps along the decks, the conductors are not of uniform section throughout, one half being 20 sq. mm. (0.31 sq. in.), and the other half 40 sq. mm. (0.62 sq. in.). The corresponding main-conductors of the port and starboard circuit on the gun and main-decks can be connected together at the fore and after part of the ship by means of switchboards, to which they are connected by supplementary conductors. The lights on the fore and after orlop-decks are regulated by auxiliary switchboards, so that they can be fed direct from the dynamos, or, in cases of need, from 150 accumulators on each deck.

The advantages claimed by the inventor for this system of lighting on war-ships are, that the laying of the conductors on the gun and main-decks in an annular path prevents the extinction of any lamp, in the case of a single injury to one of the conductors by an enemy's shell; as main conductors will be still connected at the ends to the dynamo, and the circuit will not be broken; also by joining the circuits at the fore and aft switchboards, even the total severing of one pair of the conductors leading to the main switchboard would not cause the extinction of any lamp; and thirdly, that the orlop-decks, where the chief engines of war are situated, being supplied either by accumulators or the dynamos, their illumination can be cut off only by the destruction of the decks themselves.

A Ship-Dynamo and Engine.—The accompanying illustration shows a new high-speed engine, which has been designed by Messrs. John I. Thornycroft & Company, Chiswick, England, for driving dynamos on board ship. The special characteristics of such engines should be simplicity, steadiness, and efficiency, and this engine combines these in a high degree of excellence. As it is a miniature marine engine, it will be welcomed by marine engineers as one with which they are already familiar in all its details. The engine illustrated is of the triple expansion type, and is fitted complete with its own condenser and pumps. With 150 lbs. boiler pressure and 28-in. vacuum, it indicates 50 H. P., the speed being 350 revolutions per minute. Special care has been bestowed on the perfect balancing of all the parts, and the engine is provided with a heavy fly-wheel. Suitable liners are fitted to the connecting-rod, and crank brasses to allow of easy and accurate readjustment. The engine is characterized by that excellency of design and workmanship which are the results of long experience. The first of these engines was built for the electric light installation on board the steam yacht *Thetis*, belonging to Mr. Donaldson.—*Industries*.



Iron Industry in China.—Hon. Charles Denby, Minister of the United States to China, writes from Pekin under date of May 29: "I have the honor to inclose an Imperial decree commenting on the late proposal of the Viceroy of Canton to develop the iron industry in the To-Kuang. In order to foster this important industry he has abolished the inland duties of iron and the prohibition against its export. He now proposes to investigate by a commission the subject of abolishing the heavy duty now levied on furnaces. Such a plan put into force for three years would not involve a large diminution of the revenue, but would greatly benefit the iron producers by doing away with illegal fees. He proposes, also, the creation of a joint-stock company to work the furnaces, and with foreign machinery. It would seem that the mind of this distinguished man had undergone a change. He now, while still materially seeking to retain to his own people the benefits of industrial enterprises, favors the extensive use of foreign methods in building railroads and establishing electric lights and foundries. I do not doubt that the next process in his mental development, will lead him to the only correct conclusion. That is to say, that foreign talent and honesty and will power are indispensable to the successful introduction of foreign improvements. I have long advocated the idea that the successful work of Sir Robert Hart, Inspector-General of Imperial Customs, furnishes the model for future enterprise in China. When China puts at the head of her railroad system a distinguished foreigner, and when she does this also in a department of banking, a magnificent improvement will be inaugurated which, in its results, will astonish the world."

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IT seems that electric lighting for cars has found more favor in Europe than in this country, and experiments with the electric light have been made on a number of lines. On the Midland Railroad in England, and on several of the French and Swiss lines, the success of the electric light has been so great that the International Railroad Congress recommended that the experiments be continued in preference to those with gas. The systems used have been the storage battery; the dynamo run by belting and gearing from the car axle; and the dynamo run by an engine carried either in the baggage car or in a special car. Each of these systems has its advocates, and further experiments seem to be necessary to decide between them.

AN important engineering work now in progress, which has attracted thus far very little attention, is the Transandine Railroad in South America, which is an extension of the Argentine Pacific Line, and which will, when completed, connect the port of Buenos Ayres on the Atlantic with the Chilian port of Valparaiso on the Pacific Coast. The total length of the road when completed will be 870 miles, and of this 640 miles on the eastern end and 80 miles on the western are now in operation, leaving about 150 miles in construction. This section, however, includes the most difficult work of all, the crossing of the Andes. This crossing is made at the Cumbre Pass, the summit level of which is about 13,000 ft. above the sea, but the railroad will find its highest level at 10,450 ft. above the sea, where it will penetrate the mountain by a tunnel 3¼ miles in length. On this tunnel work is now in progress, while a considerable portion of the grading of the rest of the mountain section is finished.

It was originally intended to make an ordinary railroad across the mountains, but the expense threatened to be so great that it was finally decided to adopt the Abt rack-rail system for a considerable distance; this permits the use of grades as high as 8 per cent., and not only decreases the cost, but allows the line to be made considerably shorter than it was by the original survey.

It may be noted that there will be on this line three different gauges. The Argentine section, from Buenos Ayres to Mendoza, is 5 ft. 6 in. gauge; the Chilian section from Valparaiso to Santa Rosa, is 4 ft. 8½ in., while the connecting section or mountain line is 1 meter gauge. Of course, should this line develop any considerable through traffic, these breaks of gauge will be found very inconvenient, and in that case they will doubtless after a time be made uniform.

The contractors for the mountain section are J. E. & M. Clark & Company, an English firm, and they have a large force at present employed. No date has yet been set for the completion of the line, but it is expected that trains will run through from the Atlantic to the Pacific some time in 1892.

NEW railroad construction for the nine months ending with September is reported at about 3,300 miles. A very large proportion of this is in the South, which seems at present to be the most promising field for work of this kind. As in the earlier months of the year, the greater part of the new construction is in comparatively short lines, mainly for local traffic. The present indications are that the total addition to our railroad system this year will be not far from 5,000 miles.

THE plan of putting an additional story or double-deck on the elevated railroads in New York, in order to increase their facilities for carrying passengers, is again brought to our attention by a correspondent. There is no doubt that more facilities are urgently needed now, and that the need will be very strikingly apparent when the great Exhibition in 1892 brings its additional crowds to the city. It does not seem possible that any new rapid-transit lines can be completed before that time, as the work of building would be necessarily slow, and in any case it will be a year at least before work could be begun on a new line in view of all the legal obstacles in the way.

The advantages urged in favor of this plan are that no new ground will be occupied, and that additional damages to the property along the lines of the roads will be very light. The trains could be at once doubled in number, and a great improvement in service could be secured by using one deck for fast through trains to carry passengers to the upper part of the city, and the other exclusively for way trains making all the stops. To adopt this plan it would not be necessary, probably, to replace the present structures at first. The upper deck could be erected without interfering with the old lines, and in case it should be decided to rebuild, all of the trains could be run on the new tracks for a time. New posts or supports would, of course, be necessary for the new tracks, but those might be so built and proportioned that the weight of the old trusses could be transferred to them after they were finished.

It certainly seems that it would be an advantage to have the present structures of the elevated railroads replaced. While they are good of their kind, for the most part they are not equal in design or strength to the new Brooklyn lines, or to the Suburban Elevated line, in which the experience gained in the New York lines has been turned to good account. Our correspondent's plan is not worked out in detail, but the general idea is well worth consideration.

THE building of a tunnel under the Harlem River to replace the present bridge at Seventh Avenue—generally known as McComb's Dam Bridge—is recommended by the Commission of Engineers to whom the question was

referred. This bridge will need renewal in a short time, and after considering all the circumstances, the Commission believe that the tunnel will serve the public convenience better than a new bridge. The tunnel they recommend would be about 450 ft. long, having two large passages for carriages and a smaller one for foot-passengers. The approaches on either side of the river would be 1,800 ft. long, and would have a grade of 3 per cent. The total cost, including land, is estimated at about $2,000,000.

The bridge in question connects Seventh Avenue, which is the main drive northward from Central Park, with Jerome Avenue on the north side of the river, and the travel over it is very heavy, as it forms part of the principal pleasure drive of the city. A new crossing of the river at that point is urgently needed, and either a bridge or a tunnel must be built in a short time. The tunnel would present the advantage of being free from interruption by the opening of the draw, which is a constant annoyance with the present bridge, while this obstruction will increase very much with the completion of the Harlem River improvement, when it is expected that the number of vessels using the river will be very much increased.

THE law prohibiting the use of car stoves in the State of New York, which takes effect this winter, will, it appears, be generally complied with. The only Company of any importance which resists its enforcement is the New York, New Haven & Hartford, and against this Company a suit has been brought by the Attorney-General of the State. The Railroad Commissioners recently granted an extension of time to the Central New England & Western Company, that Company having shown that it has made arrangements to introduce steam heating on its trains, and has contracted for the necessary material. A short extension was also granted by the Commission to the Pullman Company, that Company having also shown that it is equipping its cars as rapidly as possible.

THERE have been several projects for a railroad connection between England and India more or less feasible, those most favored heretofore having been for a line through Syria and the Euphrates Valley. The latest is on an entirely new line and is said to have been submitted by no less an authority than Sir Edward Watkin to the Secretary of State for India. His plan is for a line starting from Calais—using the Channel tunnel should it be built hereafter—and running thence over existing lines, with some necessary additions, to Gibraltar. Here a steam ferry would be used to carry trains across the Straits to Tangiers, whence the road would run eastward along the north coast of Africa through Egypt, Arabia, and Persia following the eastern shore of the Persian Gulf to Kurrachee, where it would join the Indian Railroad System. This plan is said to have the approval of prominent engineers and capitalists.

THE Russians thoroughly appreciate the commercial and political importance of their Trans-Caspian Railroad and are seeking to extend its connections in all directions. A concession has recently been obtained from the Persian Government for a line from Askabad southward to Meshed in Persia. The latter town is not only an important commercial point, being the center of trade for all of Northern Persia, but is also a position from which extensions of the road could be pushed in several directions. A line could be carried from Meshed through the valley of the Heri-Rud to Herat on a better line than could be obtained by working from Merv southward. In the other direction a line could be carried across the mountains to Ispahan, or, if desired, to some point on the Persian Gulf; in any event the branch would put the Russians in a position to control a large part of the trade of Persia, and also to extend the political influence which they have already acquired in that country.

A NEW and somewhat unexpected traffic is coming to the Russian Transcaspian Railroad. This is a trade with India, which native merchants have begun to carry on by means of caravans which travel from Northern India by way of Candahar to Merv, where their freight is transferred to the railroad. This has been a commercial route from time immemorial, and its present new development may have important results, both economical and political.

Since the opening of this road its commercial business has increased so much that considerable additions to the Russian fleet on the Caspian Sea have been found necessary, and a number of new steamers are now under construction for that trade.

THE International Marine Conference, which began its sessions in Washington, October 16, has an extensive programme before it; too extensive, in fact, to be fully acted upon during the limited time allowed it. All the leading maritime nations of the world are represented, however, and the conference will do an excellent work if it succeeds in establishing a uniform code of rules and signals to be used at sea. This, in fact, is its main object, and it is one which has long been desired.

THE Legislature of Pennsylvania at its last session authorized the appointment of a Commission to inquire into and report upon the possibility of constructing a ship canal to connect Lake Erie with the Upper Ohio River. The Commissioners, as appointed by the Governor, are John A. Wood and Reuben Miller, Pittsburgh; W. S. Shellenberger, Rochester; John M. Goodwin, Sharpsville; Eben Brewer, Erie. This Commission was to meet for organization in Pittsburgh, October 24. Its work will be preliminary, and is intended to provide information upon which the Legislature can base future action.

ENGINEERING IN NAVAL WARFARE.

THE stupendous changes which have been and are still being made in the construction of modern war-ships, should and must direct public attention to the kind of knowledge and skill which is now most essential in the conduct of our naval affairs to make that arm of our service equal or superior to that of other nations, and to secure success and victory in case of war. The belligerent propensities of the civilized portions of mankind are now held under so much restraint, and inventive and constructive faculties are so freely and so actively exercised, that the means devised for attack and defense are seldom subjected to adequate tests in actual warfare before they are supplanted by some new device or discovery more effective and destructive than those were which have preceded it. It is not surprising, then, that there should be great differences of opinion with reference to the value and efficiency in actual war of many of the diverse kinds of ships, armor,

guns, and machinery, which every civilized nation in the world is now engaged in constructing. Fortunately there has thus far been no adequate opportunity of testing the powers of offense or defense of the most modern war-ships and their armament. Nearly all other machinery when it is completed is put into the service for which it is intended: its efficiency is thus tested, its defects are made apparent, and are remedied as the light of experience may indicate is needed. With the mechanism of naval warfare it is different. All that can be done is to reason on past experience with quite different appliances, and seek for information by means of tests, trials, and experiments, and occasionally, as the boys say, "fighting in fun."

There are certain facts, however, which are made apparent by sham warfare, and the exercise of that kind of prescience which comes from knowledge and experience in designing, constructing, and using engineering appliances of almost any kind. One of these facts is that a modern war-ship and its armament is essentially a creation of mechanical engineering.

The conception and design of the ship, its armor, engines, guns, and machinery are a consequence of the exercise of a knowledge of the principles of their construction, the properties of the materials used, and the multifarious processes, arts, and appliances which must be employed in their manufacture. When completed it is a great aggregation of mechanism, a thorough knowledge of which, with skill in its use, are essential to the successful operation of the ship. When sailing vessels were used, the most important personage on board was the officer who directed the navigation. He had a thorough knowledge of his calling, and had the best opportunities of becoming acquainted with the rigging and other appliances for sailing his ship. The introduction of steam, however, changed all this. The speed of vessels was much increased thereby, and by means of which commanders and navigators are usually quite ignorant. The offensive and defensive power of a ship is now largely, if not chiefly, dependent upon its means of propulsion. As Commodore Ramsay is reported in one of the daily papers to have said recently:

Speed is one of the chief requisites in a war-vessel. In modern naval warfare a slow man-of-war is efficient in comparatively few engagements. A vessel with fewer guns, which can move about with great rapidity and get in position, has an advantage over a heavily armed and well-protected vessel which does not possess great speed.

If there are two cruisers of exactly the same dimensions, the same armament, the same crew, whose officers are equally efficient, and one can sail a knot an hour faster than the other, she will whip the slower ship just as sure as they have an engagement.

Much light is thrown on the actual condition of affairs in the different navies of the world by a report recently published of the manœuvers of the British, Italian, and Spanish navies. Of the British manœuvers it is said: "From all sides came complaints of defective machinery. The squadrons were constantly impeded in their speed and in their movements by 'lame ducks' needing repairs." The best speed one of the ships could make was 8 knots, others steamed at 9 knots with difficulty, four of them had hard work to keep up 10 knots, the *Mersey* could only make 14½, and had to slow down to clean tubes; the *Mohawk* class failed in boilers and boiler tubes, the *Raccoon* practically broke down, and the *Serpent* was almost constantly under repairs. Most of the torpedo-boats gave trouble, and nearly all the fast cruisers failed to steam up to their nominal speed.

After the manœuvers of the Italian Navy, it was said in a newspaper that seven of the ships would each need 12 days' repairs, and five others from 10 to 30 days, and 13 torpedo-boats 10 days each.

In the Spanish torpedo-boat manœuvers, the crown sheet of the boiler of one boat collapsed and killed four men, another which came to her relief damaged her machinery, a third bent her propeller blade, and a fourth had a boiler disabled.

A record like this made in times of peace shows how dependent the efficiency of a navy is on the machinery of its ships; or, as Lieutenant Stanton, of the United States Navy, has written: "In these days of mastless armored ships, of coal and countless mechanisms, torpedoes, electricity, and rifled guns, a dozen shops and factories contribute to the outfit of a single ship, and a misfitting valve may cause disaster."

It is of the utmost importance, then, not only that a war-ship should be fast, for, as Commodore Ramsay says, "a fast ship always possesses high offensive power because she is fast, and if she cannot fight successfully she can get away;" but a war-ship must also have the merit of not breaking down in service. In actual war probably most of the ships which were disabled in the British, Italian, and Spanish manœuvers would have been captured by the enemy. In a battle the most skillful navigator or the greatest master of naval strategy could not save a ship if the valve-gear broke down or a tube collapsed. Engines should be designed not only to give the required speed on a trial trip, but so as to be reliable while in service. Doubtful, untried, and hazardous forms of construction may expose a ship and its crew to danger, which will be fatal to both. The ability to discriminate among those forms of construction which are safe and can be depended on to do efficient service, under all circumstances, comes only with a thorough knowledge of the subject, ripe experience, and a sound judgment, and unless the designs of the machinery with which our war-ships are equipped are determined by officers with such qualifications, the history of our Navy will be the occasion of humiliation to all of us.

The inference to be drawn from these observations is, that the engineering department of our Navy is the most important branch of its service at present, and perhaps always will be.

For some reason, which is not easy to understand, there seems to be a distinct tendency in republican governments, which is averse to recognizing the value and importance of a thorough knowledge and experience on any subject which is difficult to comprehend fully. Such qualifications seem to excite a feeling of resentment in the democratic mind. There are evidences of this in the estimation in which the construction and engineering departments of our Navy are held by the average Congressman and others higher in authority. The type of man who holds the most exalted position in the mind of the ordinary politician is what is known as a "hustler," than whom none is more unfit for the duty of designing or judging of designs of ships, engines, guns, or any other mechanism. It is conceivable that a "hustler" might command or fight a ship successfully, but could do naught else but blunder if intrusted with its design. If we should have a foreign war —and we are not entirely free from that danger—it will be possible to find men to navigate and fight our ships, if they are planned and built as they should be, but neither

skill, courage, knowledge, nor "hustling" will avail if our Navy is composed of vessels which are slow, whose engines break down, and whose boilers will not make steam. In constructing our Navy, competent engineers are imperatively needed, and no knowledge of naval tactics or navigation will avail during hostilities if the engines are in incompetent hands. In other words, naval warfare has become an engineering contest, and the branch of the service which designs and controls the mechanism of our ships should be honored as much and paid as well as any other in the Navy. The ability to design machinery does not come by nature; although much depends upon natural aptitude, without experience, and a great deal of it, no amount of knowledge or talent will be sufficient. Thousands of matters of detail must be mastered, there must be fertility of invention in adapting means to ends, unlimited resources for overcoming difficulties, many of which have become matters of tradition; safe conservatism which keeps well within the bounds of certainty and yet avails itself of all the latest improvements; a semblance of omniscience which gathers in all existing information relating to a subject and then deduces infallible conclusions therefrom; a kind of mental gravitation to the safe side of doubtful questions, with a receptive faculty which keeps the doors of the mind wide open to take in all new ideas that are valuable—these are the qualifications of a superior mind, and in that branch of our naval service where they are so essential, should be honored by rank and authority.

IRRIGATION.

A STRIKING incident of the Congress of Engineers on the Utilization of Waters, which was held recently in Paris, was an address made by the Mandarin Tcheng-Ki-Tong. "Your western civilization," said the representative of China, "is admirable in many respects; we of the Far East admit your skill in construction; you can build hydraulic machinery of the most efficient kind; your pumps and other apparatus surpass anything that we have, and in controlling the flow of your rivers and building magnificent structures to cross them, you have the advantage of us—but in the real utilization of water for the purpose for which we in China believe that Nature intended it, your civilization has not yet reached the point to which ours attained 4,000 years ago."

With this introduction, the Chinese engineer proceeded to prove his assertion and really made out a very strong case in favor of his claim. In China from the earliest historical times there have existed very extensive works for the irrigation of the land, and the Chinese farmer many years ago ceased to depend upon the rain, or the uncertainties of the weather, for the prosperity of his crops. There the most apparently barren and useless land has been made to produce two or three crops per year, and the Government long ago realized the fact that upon the proper storage and distribution of the waters depended the real prosperity of the country.

It is true that in some portions of France, Spain and Italy systems of irrigation have been in use for a number of years, but they do not approach either in completeness of design or execution to those which were carried out in China long before the Christian era—3,000 years, in fact, if the claim of the native historians be true.

From present indications, however, it seems probable that before many years the reproach which was thus cast upon western engineers will be removed by the action taken in this country. The settlers in Southern California early realized the fact that to make that section a productive one, irrigation must be employed, and the rainfall which was sufficient in quantity, but which did not come at the proper season of the year, could only be made to assist the soil in producing crops by some system of storage and distribution. The experiments made in scattered localities and on a small scale, proved so successful, that later arrangements were made for concerted action, and companies were organized with sufficient capital to divert the course of rivers, erect dams and storage reservoirs, and provide the necessary flumes and canals for distributing water on a large scale. In almost every case these have been successful and have encouraged the continuation of the work until it has become probable that in a few years nearly all the farmers of Southern California will depend wholly upon irrigation for their success.

The California example has been followed to some extent in the territories, where it was ascertained by careful experiments that the water furnished by the winter rains and the mountain snows would, if the supply was stored and equalized, be sufficient for the needs of cultivators throughout the year. Experiments made by enterprising pioneers in Montana, Idaho, Utah, Colorado, and Arizona have proved that large areas, which had been regarded as barren and desert country, could be made by irrigation to produce crops as great or even greater than are obtained from the fertile lands of the Mississippi Valley. The results in some cases have been extraordinary and have encouraged undertakings of a similar kind on a larger scale.

Under these circumstances a movement in favor of extending and regulating the systems of irrigation has sprung up on the Pacific Coast and in the Territories, which was strong enough last year to secure the appointment of a special committee by the United States Senate for the purpose of considering the whole subject, and recommending such action on the part of the Government as may seem to be necessary and judicious. The conformation of much of the so-called desert land of the West is such that to provide a proper supply of water for this purpose, extensive works will be needed, and it is uncertain whether individual or corporate enterprise will be able to carry out all of this in the proper way. At any rate, whether national aid is desirable—and this is certainly still an open question—some national regulation must be had in order to prevent confusion, litigation, and perhaps waste of resources. In many cases the storage reservoirs must be established in mountains at long distances from the points where the water is to be used, and litigation may easily rise between claimants for the sources of supply. Moreover, there are many legal points in relation to water-rights, and a definite system of irrigation law would seem to be one of the necessities of the situation before capital can be freely applied for this purpose.

It will be readily seen how, without proper regulation the ownership of water-rights and irrigating canals might be developed into a vexatious monopoly which would hold the farmers at its mercy and subject them to intolerable exactions. It will also be seen that in many cases a partial and unsystematic course of proceeding might prove wasteful and injurious, and would fail to develop the water resources of the country to the best advantage. The Senate Committee in its labors has had the assistance of experts

of wide experience, and something in the same direction, has been done by the Geological Survey—a work which is to be continued.

The State of Colorado, in which some of the earliest practical demonstrations of the possibilities of irrigation were made, has provided an excellent code of water laws, which has so far worked very well, and which may serve as a model for future legislation, either State or National.

The subject is one of great importance, and upon its proper treatment may be said to depend the future prosperity of a large section of the West, and the adaptation for agriculture of the greater part of the public lands which are still unsettled.

THE WORLD'S SHIPPING.

THE accompanying table, compiled from the *Universal Register*, gives the total number and tonnage of all the seagoing vessels in the world in 1888. The first, second, third, fourth, fifth, sixth, and seventh lines in each table show the number of vessels owned by Great Britain (including the colonies), the United States, Norway, Germany, France, Italy, and Spain, and the eighth line shows the total for the world, including all minor countries, as well as the seven named. No vessels under 100 tons are included in the list.

I.—STEAMERS.

	No. of Vessels.	Tonnage.	Av. Tonnage.
1. Great Britain	5 914	7,304,815	1,235
2. United States	425	516,251	1,215
3. Norway	329	185,399	564
4. Germany	640	726,044	1,134
5. France	490	740,325	1,511
6. Italy	201	284 369	1,415
7. Spain	380	398,733	1,048
8. The World	10,260	11,552,101	1,126

II.—SAILING VESSELS.

	No. of Vessels.	Tonnage.	Av. Tonnage.
1. Great Britain	6,103	3,524,387	577
2. United States	3,148	1,401,924	445
3. Norway	2,929	1,270,865	434
4. Germany	1,292	683,794	530
5. France	920	244,621	266
6. Italy	1,461	562,532	317
7. Spain	574	139,048	242
8. The World	22,402	9,496,603	424

III.—TOTAL, STEAM AND SAIL.

	No. of Vessels.	Tonnage.	Av. Tonnage.
1. Great Britain	12,017	10,829,202	901
2. United States	3,573	1,918,175	537
3. Norway	3,258	1,456,264	447
4. Germany	1,932	1,409,838	729
5. France	1,410	984,946	699
6. Italy	1,662	846,901	510
7. Spain	954	537,781	564
8. The World	32,662	21,048,704	644

No other nation than the seven named owns over 500,000 tons of shipping.

It will be seen that sailing vessels compose 68½ per cent. in number and 45 per cent. in tonnage of the world's seagoing fleet. Vessels for river or inland navigation are not included in the *Register*.

Great Britain owns 63¼ per cent. of the steam tonnage, 37 per cent. of the sail tonnage, and 51½ per cent. of the total tonnage. That country also, as will be seen from the table, owns the largest vessels, the average tonnage being the highest, except in steamers, where France and Italy show greater averages; but the number of steamers owned by those countries is small.

It may be noted that while there was during the year a slight increase—283,059 tons—in the total tonnage, the gain was entirely in steamers, the sail tonnage showing an actual decrease of 323,889 tons—that is, the tonnage of new sailing vessels built last year was considerably less than that destroyed by wreck or broken up from old age. This has been the case for several years past, and the process of substituting steamers for sailing vessels has been gradually going on all over the world.

There has also been going on a gradual increase in the average tonnage, which has in four years increased from 607 to 644 tons, a gain of 6 per cent. This is partly due to the increase in number of large steamers.

It is possible that this tendency to decline in sail tonnage may receive a check, for a time, at least, since there are at present a number of large sailing ships under construction in Europe, including several designed for carrying oil in bulk. In this country, also, there is a tendency to the building of large sailing vessels for the coasting trade.

What especially concerns us is the low position which the United States holds in the list as compared with Great Britain. With a very extensive coast line and great resources for building ships, our tonnage, both steam and sail, is really insignificant when compared with that country. This question has been the subject of much inquiry, and all sorts of plans have been proposed to improve this state of things. The true solution of the problem has not yet been reached, however, and should still be carefully sought.

It is a very important one, for every succeeding year increases the proof of the rule, laid down many years ago by a great economic writer, that "No nation ever has been, or ever will be truly great commercially, which does not carry its own freight in its own bottoms."

NEW PUBLICATIONS.

A MANUAL OF MACHINE CONSTRUCTION FOR ENGINEERS, DRAFTSMEN, AND MECHANICS: BY JOHN RICHARDS. Philadelphia; J. B. Lippincott & Company.

This book might be described as a volume of mechanical generalizations. In his preface the Author says that he "once supposed, and ventured to claim, that constructive processes, arrangement and proportion of machine parts could be made amenable to exact, or measurably exact rules. This opinion has been abandoned for a belief that special knowledge and experience must remain the greater part, and books, references and rules can deal only in a limited way with constructive engineering."

These remarks indicate the character of the book, which consists of a series of observations with reference to machine construction, followed by illustrations and data concerning its proportions. Thus, in the first chapter there is a description and illustration of a drill-press in which the reasons are very clearly set forth for the general arrangement of the different parts or organs of the machine. This is followed by short dissertations on the sectional forms of machine framing, standards, supports, ribs and fly-wheel rims, pulley spokes, bosses for screws and nuts, and, when the subject admits of it, tables of dimensions for such parts of different sizes.

In the second chapter bearings, shafts and spindles are treated in very much the same way. There is first a table of ingredients for alloys for machine bearings; then descriptions and illustrations are given of journal bearings

for wood framing, rigid bearings, heavy pedestal bearings, diagonal bearings, pivoted pedestal bearings, adjustable pivot bearings, suspension brackets, counter-shaft brackets, tapered bearings, spindle and Schiele bearings—a brief description, with a few suggestive observations and a table of the principle dimensions for such bearings of different sizes. Without treating these subjects exhaustively, it gives just the kind of information which a draftsman, mechanic or any designer of machinery often wants to get off-hand, without spending any time in wrestling with mathematical formulæ or deciphering the obscure English in which it seems to be the fashion now for technical writers to hide their ideas.

The following remarks on radial bearings is given as an example of the Author's clear treatment of a subject which is generally very imperfectly understood :

These bearings, with their surfaces moving at different velocities, are one of the worst things to contend with in construction, and are responsible for a great share of the difficulties in operating machines. It is ignorance or disregard of this principle that has led to a great waste of time and effort expended on rotary engines and rotary pumps.

The diagram, fig. 36, is drawn to illustrate the principle of radial bearings. It is an exaggeration of actual practice, but corresponds in operation to collars, end bearings and so on.

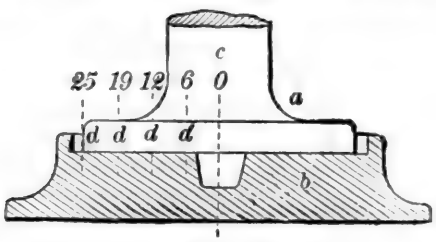


FIGURE 36.

The disk *a* is supposed to revolve on the seat *b*. If the disk *a* on the shaft *c* is 8 in. in diameter, the velocity at different distances from the center will be approximately as the figures on the lines *d*, varying from 0 to 25.

Now, supposing wear to take place, as the velocity or the distance moved, and that such wear—even one-thousandth part of an inch—will relieve pressure, it is easy to see that the pressure will not be distributed equally, but will begin at the center and increase there until the faces are destroyed. With this in view it is easy to understand how radial faces in pumps and engines cannot be kept steam or water-tight. The velocity being directly as the length of radius, it is obvious that thrust-bearings of all kinds, with radial faces, should consist of shallow collars in order to secure a more uniform velocity of the surfaces.

Modern thrust-bearings for propeller shafts are an example. Every attempt to receive this enormous pressure on faces with long radii, or wide faces, was a failure. End screws or points equally so, because of the small surface. The Schiele bearing being too large in diameter, and not understood in most cases, the natural result followed. The radius or depth of the collars was reduced to one-eighth part of the whole radius, and the number of collars increased, until the pressure on the aggregated surfaces fell within a practical working limit. This done, there has been no further difficulty in resisting a thrust equal to 5,000 or even 10,000 horse-power.

The same rule applies everywhere and in all cases ; either the surfaces must have short radii or else they must conform to the curve of equal tangents shown in fig. 27, otherwise they are soon destroyed.

A study of this subject is commended to the inventors of rotary engines and pumps, also to any one who designs machinery involving radial faces to receive pressure, or to retain liquids or gases.

The following are the titles of the chapters which contain much useful information and many interesting suggestions : Machine Design ; Rotary Bearings ; Sliding Bearings ; Power Transmission ; Driving Belts ; Rope Driving Gearing ; Hydraulic Transmission ; Steam Machinery ; Connecting Rods ; Cross-heads for Engines ; Steam Boilers ; Hydraulics ; Water Power ; Water-Raising Machinery ; Centrifugal Pumps ; Pipes and Fittings ; Mechanical Drafting ; Heat ; Dynamics ; Properties of Material ; Tables and Memoranda.

The printing, paper and engravings of the book are admirable—as the work which issues from the Lippincott press always is—but the form of the book is not to be commended. Its size is 6¾ × 11¼ in., with limp covers, and it is bound and opens on the end. The lines run crosswise of the page, so that in reading it the book must be held with the long dimension of the pages in a vertical position. As the book is 22 in. long when open, it is extremely inconvenient to hold up, and it cannot be read with any comfort without a table or desk to lay it on.

It is also without an alphabetical index, for which omission there is no excuse for either Author or publisher.

A TREATISE ON MASONRY CONSTRUCTION : BY IRA O. BAKER, C.E., PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF ILLINOIS. New York ; John Wiley & Son, 15 Astor Place (price, $5).

This book, to quote from the Author's preface, "is an outgrowth of the needs of the Author's own class-room."

Possibly the book was written simply for a text-book, but the result has been a book that will certainly prove of value to the practising engineer for a number of years to come.

There is one point that the examination of this book and some other of the recent engineering text-books brings forcibly before us, and that is the marked change that has taken place within comparatively few years in the subject-matter presented to students in the various schools of engineering. The amount of abstract theory given has been reduced and its quality greatly simplified. Much attention is now given to bringing before the student, in a most forcible manner, the intimate relation existing between correct theory and truly economical practice, and that no practice can be either physically or economically good that does not conform with correct theory ; also to clearly setting before the student the *relative importance* of the various points developed in both theory and practice.

This becomes necessary in order to guard against an extreme refinement of practice on the one hand that costs more than it is worth, and an extravagant use of material on the other.

This use of "erring on the safe side," as it is called, results simply in a waste of material and money on light work with possibly some increased safety, but in heavy work, such as long-span bridges, becomes a source of positive danger. This book is a most excellent example of the manner in which a subject should be presented to students in our four years' course in civil engineering.

For convenience the subject is divided as follows :

Part I. Description and Characteristics of the Materials.

Part II. Methods of Preparing and Using the Materials.

Part III. Foundations.

Part IV. Masonry Structures.

Part I includes not only a description of the materials, stone, brick, lime, and cement, with their characteristics, but their requisites, methods of manufacturing brick, lime, and cement, together with some of the latest and most simple methods of testing their qualities.

Part II includes a description of the methods used in

the manufacture of mortar, concrete, and artificial stone, and the quarrying and dressing of stone for the construction of masonry.

Part III is on Foundations, including 1. The ordinary foundation, which subject is divided into three heads, viz.: (1) Soil; (2) Designing the Footings; (3) Preparing the Bed.

2. Pile Foundations: (1) Methods of Driving Piles; (2) Bearing Power of Piles; (3) Arrangement of the Foundation.

3. Foundations under Water: (1) Coffer Dam; (2) Crib and Open Caisson; (3) Dredging through Wells; (4) Pneumatic Process; (5) Freezing Process; (6) Comparison of Methods.

Part IV is on Masonry Structures: First, on Masonry Dams, including: (1) Stability of Dams; (2) Outlines of Design; (3) Rock-Fill Dams, including a comparison of Wood, Earth, Rock-Fill, and Masonry Dams. Second, on Retaining Walls, including: (1) Theoretical Formulas; (2) English and American Empirical Rules, with Details of Construction; (3) Bridge Abutments. Third, on Bridge Piers, including: (1) Theory of Stability; (2) Details of Construction. Fourth, on Culverts, including: (1) Water-Way Required; (2) Box and Pipe Culverts; (3) Arch Culverts. Fifth, on Masonry Arches, including: (1) Theory of the Masonry Arch; (2) Rules derived from Practice; (3) Arch Centers. There is also an Appendix giving Specifications for Masonry: (1) General Railroad Masonry; (2) Masonry Railroad Buildings; (3) Architectural Masonry; (4) Laying Masonry in Freezing Weather.

In the treatment of each of the above-mentioned subjects sufficient theory is given for the student or engineer to comprehend fully the general principles upon which sound practice must be based, and also full descriptions of numerous examples of actual work, together with a comparison of the results obtained by the use of the different methods and materials in practice.

The various portions of the book contain also the essential parts of the standard specifications of some of the best organized railroad companies in this country. There is one advantage Professor Baker has in placing this book before the engineering profession, and that is that it is the only book of its kind on the market, the only data upon the different points being scattered through proceedings of engineering societies and various engineering journals, and not available to the majority of students or engineers.

As a text-book it will well fill the purpose for which it was written, and it will also be a valuable addition to any engineer's library.

The Railway Lighting and Heating Company's Frost Dry Carburetter System for Lighting Passenger and Other Railroad Cars. Philadelphia.

This is a trade publication which describes the system of lighting cars mentioned in the title above. It forms a volume of 36 pages $9\frac{1}{2} \times 12$ in., besides a number of folded lithographic plates. It begins with an advertisement of the system, which is succeeded by a comparison of the cost of service of five different systems of lighting cars. Instructions for "manipulating" the apparatus are succeeded by a general description of it and a list of parts necessary for the equipment of a car. The application of the system and its different organs are illustrated by excellent lithographic engravings, which are admirable examples of the draftsman's art, especially plates C and D. The printing and paper are both luxurious, but the "General Description" on pages 15-17 can hardly be regarded as a model of lucidity, although as trade catalogues go it is very good.

Temporary Catalogue of the Boyden Power Brake Company. Baltimore.

In an introductory note or preface to this publication it is announced that it is a "temporary catalogue," issued to meet the immediate demands of the business of the Company, and that in the future a more complete descriptive catalogue will be issued. This statement to some extent disarms criticism, and perhaps all that need be said now is that the catalogue is a pamphlet of 26 large pages, and contains descriptions and engravings of the principal parts of the brake, which, in its general character, resembles the Westinghouse, although the mechanical appliances used differ considerably from what may be called the organs of its prototype. The engravings are good, and the mechanical work of the catalogue can also be commended, although the descriptions are, perhaps, not as full nor as clear as might be desired.

BOOKS RECEIVED.

Trade and Transportation between the United States and Spanish America: by William Eleroy Curtis. Washington; Government Printing Office.

High Pressure Steam and Steam-Engine Efficiency: by W. Worby Beaumont. London, England; published for the Author. This is a paper read before the Society of Engineers by Mr. Beaumont.

Reports of the Consuls of the United States to the State Department: Nos. 107 & 107½, August, 1889. Washington; Government Printing Office.

The Railways of Brazil, a Statistical Article Reprinted from the Railway Age, with Notes and Additions: by John C. Branner, Ph.D. Chicago, Ill.; the *Railway Age* Publishing Company.

Regale Universita Romana, Scuola d'Applicazione per gl' Ingegneri: Annuario per l'Anno Scolastico, 1889-90. Rome, Italy; published by the University.

Occasional Papers of the Institution of Civil Engineers. London, England; published by the Institution. The papers included in this issue are Removal of Rock under Water without Explosives, by Frederick Lobnitz; the Steel Dock-gates of the Limerick Floating Dock, by William J. Hall; Foundations of Daly College, Indore, by David M. Litster; Movements of Sewer Air, by William S. Crimp; Perforated Cake-powder for Ordnance, by George Quick; West of India Portuguese Railway and Harbor Works, by Ernest E. Sawyer; Water-softening and Filtering Apparatus for Locomotive Purposes; Abstracts of Papers in Foreign Transactions and Periodicals.

Anales de la Sociedad Cientifica Argentina: Entregas IV y V, Abril y Mayo, 1889. Buenos Ayres, Argentine Republic; issued by the Argentine Scientific Society.

Cornell University, College of Agriculture. Bulletin of the Agricultural Experiment Station, Horticultural Department: IX, September, 1889. Ithaca, N. Y.; published by the University.

Central Experimental Farm, Department of Agriculture: Bulletin No. 5, August, 1889. Ottawa, Canada; issued by the Department of Agriculture.

Annual Report of the President and Directors of the Ohio & Mississippi Railway Company to the Stockholders. Cincinnati, O. ; issued by the Company.

Pencoyd Iron Works : Steel Car Axles. Philadelphia ; A. & P. Roberts & Company. The Pencoyd Iron Works have been engaged in the manufacture of iron car axles since 1852, and for several years past have made steel axles also, the plant consisting of one 20-ton and two 3-ton hammers, with the necessary furnaces, cranes, and other appliances. The present pamphlet contains in tabular form the results of a long series of tests of steel and iron axles made at these works.

The Midgley Wire Belt Company : Catalogue. Beaver Falls, Pa. ; issued by the Company.

Penn Iron Roofing & Corrugating Company : Catalogue and Description. Philadelphia ; issued by the Company.

Injectors : Catalogue of the Rue Manufacturing Company, 1889. Philadelphia ; issued by the Company.

True Inwardness : by an Honest Man. Second Edition. Newton, Mass. ; published by Sterling Elliott. This is a revised and enlarged edition of a catalogue which is unique and very attractive in its way.

Buckeye Portland Cement : Process of Manufacture, etc. Bellefontaine, O. ; issued by the Buckeye Portland Cement Company.

ABOUT BOOKS AND PERIODICALS.

The last quarterly number of the Proceedings of the United States Naval Institute contains an interesting article on Electricity on Board War-ships, by S. Dana Greene, late Ensign, U. S. N. ; a description of the Homestead Steel Works, by W. Richards and J. A. Potter ; and an account of the Naval Ordnance Proving Grounds, by Lieutenant Albert Gleaves, U. S. N. Other articles are on Quick's Perforated Powder, by Fleet Engineer George Quick, R. N. ; Shipbuilding on the Pacific Coast, by Lieutenant-Commander F. P. Gilmore, U. S. N., and a continuation of Professor Munroe's Notes on the Literature of Explosives. There is also the usual variety of notes on naval matters of interest.

The September number of the Journal of the New England Water-Works Association contains the report of the annual convention, with the papers read at that meeting, including several of especial value to engineers engaged in this class of work. The report of the topical discussions also includes much that is of interest.

Mr. Kennan's description of the silver mines of Eastern Siberia in the October Century—setting aside its special object, the description of the Russian convict system—will make a mining engineer grieve over the condition of a rich country with resources wasted by mismanagement. In its war papers the Century has recently treated of telegraphy in war time ; it might be suggested that something about railroad work in the same period would be of interest.

The Popular Science Monthly for November will contain several articles of interest to engineers. Indeed there are very few numbers of this magazine which do not present something of special value to this class of readers.

That very excellent paper the *Engineering and Building Record* has added to itself a bright red cover, increasing its size by the four pages which the cover makes. Very critical people may find fault with the shade adopted ; but it has the merit of being distinctive and readily recognized, and is a gratifying evidence of well-deserved prosperity.

FIRE-BRICK FIRE-BOXES FOR LOCOMOTIVES.

To the Editor of the Railroad and Engineering Journal:

In perusing your valuable Journal of October, I became somewhat interested in the results obtained by Mr. Stefan Verderber upon Hungarian Railroads as well as those of Mr. Thomas Urquhart.

The more I studied the system, the more I feel in favor of the change that is requisite to be made in this variable climate of ours. I have had some experience, having had charge of locomotives and their construction in all climates, from the torrid climate of the Equator to the extreme cold of a Canadian winter, and in the more temperate zone of the Central States of America. It is a well-known fact, which is answered by the expense account of the American railroads in winter, that during summer very little trouble is experienced with bad flues, leaky fire-boxes, and cracked sheets. When December sets in, and winter, with its cold, chilling winds encounters the locomotive and commences to attack the vital part, which, like the human system, is the body or boiler, and lays its demand with unsparing hand not upon the cylinders, wheels, etc., at first, but on the vital parts, the fire-box, flues, and internal arrangements—the power-generating qualities, its very life—then immediately the trouble begins, and extraordinary exertions are made to generate the amount of steam required under the worst of conditions and climatic influences extant ; causing extraordinary expansion from excessive heating of inside sheets, flues, etc., and fearful strains from outside influences of temperature, working in favor of contraction. This means an increase of repairs and expense account.

I am fully convinced that an immediate improvement can be made in the right direction, lessening not only the cost of production, but also the expense and repair account, by a proper change in construction.

I deem the method of lengthening the boiler or cylinder part and lengthening flues as part and portion of this improvement, and placing what was formerly the throat of the boiler inside of the furnace with a suitable crown sheet, the furnace being lined with fire-brick, which can never be suddenly affected by either the heat or cold ; which sudden changes so often prove deterimental to the sheets, stay-bolts, etc., of the ordinary boiler as built. This method may involve the relaying of fire-brick in the furnace much oftener than repairing sheets, but will it not more than compensate by the gain in expense account, and by giving a safe, durable, and whole boiler for a greater period of time? I think so. I feel satisfied that these undue influences of heat and cold would have nothing to attack, either by cold draft outside or circulating drafts upward on the inside fire-sheets of a boiler of this description, as there would be none of those conditions to influence it before it could enter the flues to imperil their durability, while passing through the process of combustion, in reaching the sheets and flues of the cylinder boiler as proposed.

It is well known that some of the severest strains on a locomotive boiler result from the great expansion inside and the contraction outside—due to the action of cold on the side-sheets, etc., which it is impossible to cover properly. These strains tend to injure or break the stay-bolts, etc., which hold the inner and outer fire-box sheets together, but their effect is too often ignored.

Not having tested the matter fully, I feel convinced that less than 33 per cent. of the steaming qualities are in and around the water-space of the ordinary fire-box. From my observations on the fires on different locomotives, I have known—among that number are many of the present American build, some French, and a great many of English manufacture, when engaged as locomotive engineer in Canada for several years where the Gunn, Good, Stephenson, Bristol, Fairbairn, Liverpool, and Birkenhead engines were in use—let me add that a boiler constructed on a good design, not remodeled from an old shell, but built from new material ; one that would be designed for circulation of the water from the fire, toward the forward end, will be ultimately the locomotive boiler of the future. Such a design I should be in favor of applying and believe would be the most serviceable. Walter S. Phelps.

THE THAMES RIVER BRIDGE.

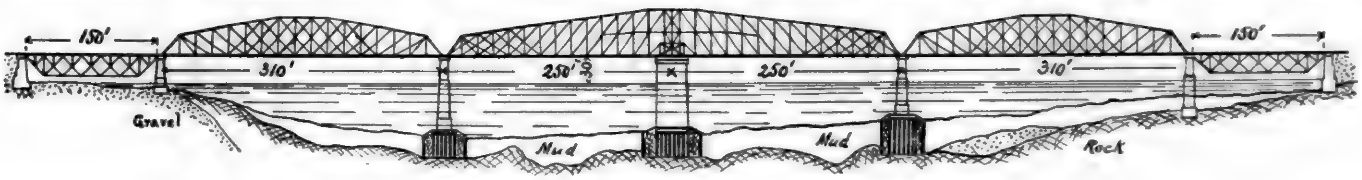
THE new bridge over the Thames River at New London, Conn., is now completed, and was opened for traffic on October 10. This bridge was built to complete the connection between the Shore Line Division of the New York, New Haven & Hartford Railroad and the New York, Providence & Boston Railroad, and to do away with the ferry heretofore in use across the river at New London. By its completion, the Shore Line between New York and Boston will have a continuous track and the delays incidental to the ferry transfer will be done away with.

The bridge (which was described in the JOURNAL for June, 1888, page 264) crosses the Thames River at Winthrop's Point, about half a mile above the present ferry crossing. This is the narrowest part of the river, but the nature of the bottom there required some difficult work on the piers; the place, however, was chosen chiefly for the reason that at that point the bridge would not interfere with the free access of shipping to the wharves at New London. Beginning on the western or New London side of the river, the bridge consists of one deck-span 150 ft. long; one through-span 310 ft. long; a draw-span 502 ft. long, having a clear opening of 225 ft. on each side of the center pier; one through-span 310 ft. long, and one deck-span 150 ft. long; the total length of the bridge is thus 1,422 ft. The bridge is entirely of steel, is built for a double track, and has a clear headway above the river of 30 ft. at high tide.

The western approach to the bridge is made by a line running from the present Union Station in New London northward until nearly opposite the bridge, where it turns eastward by a sharp curve, crossing the New London Northern track near the bridge. On the eastern side a new line has been built from the end of the bridge to Noank, which is somewhat shorter and very much straighter than the old road.

The surveys and plans for the bridge were made by Mr. Alfred P. Boller, of New York; the contractor for the foundations and masonry was Alexander McGaw, of Philadelphia; and for the superstructure, the Union Bridge Company, of New York.

An interesting feature in connection with the bridge is the machinery by which the draw is turned, and the ends of the draw-span dropped into place. This machinery is thus described: The engine for turning the draw is located beneath the middle of the roadway on top of the pivot pier, and, of course, turns with the structure as it revolves. It is a very compact steam plant, stowed away between the deep steel cross-girders, and the engine-room is to be housed in with double floor and hard pine finish, with iron stairways leading down to it. The engine is a double oscillating cylinder engine, with both cylinders 7 × 10 in., set at an angle of 120°, and both working upon one crank shaft. It is built by Joseph Edwards, of New York, and is especially designed for bridge turning. The power is transmitted by geared wheels proportioned 16 to 1, and is distributed to the turning pinions or to the rail-elevating and seating devices through the medium of two Frisbie clutches, which in turn are governed by levers bearing a toothed quadrant and operated simultaneously in opposite directions by a hand-wheel. The main gear-wheels are 36 in. in diameter, and are so combined with the clutch mechanism that as the power is taken off one set of gears it is applied to the other. The functions of this engine then are double. Extending under the floor of the draw-span for its entire length is a shaft carrying at its outer ends a worm which operates a series of cams upon a transverse shaft under the bridge floor. The end length of rail at each end of the draw-span projects 2¼ ft. beyond the draw proper and this rail is fastened by a fish-plate only at its inner end. It lies in a trough made of angle-bars bolted to a base-plate, being free to move vertically for nearly its whole length. Its outer end is elevated by means of these cams, one of which is located under each rail at each end of the draw. These rails have planed ends so devised that a train running in either direction is running off the points, and on the thicker end of the other rail and in their normal position with the draw closed, they meet and exactly fit corresponding planed rails upon the fixed through spans, which lie in a shorter channel formed of angle-bars. This mechanism is somewhat similar to that employed at the Norwalk drawbridge. Something less than a complete revolution of these cams operates to elevate the ends of the rails at the draw-span above the rails of the fixed span, thus unlocking the track and allowing the draw to be turned. At the same moment, and by means of the longitudinal shaft through beveled gears and a lower transverse shaft, a vertical sleeve, cut with an interior female screw, is actuated, operating to raise a male threaded shaft carrying on the lower extremity a bearing-plate having a 6-in. downward projection which exactly matches a slot in the seat on the outer pier of the fixed through-span. The lifting of this seating device and the elevation of the rails is simultaneous, there being four of the seating screws to be freed from their complementary halves before the draw can be moved. This having been accomplished, the engineer throws over his hand from the shaft extending the length of the draw, and so throws into gear the shafts actuating the pinions which mesh into the circular rack around the top of the pivot pier. Two of these pinions are under the middle of the bridge on either side of the pivot pier, and when they begin walking about the rack the 1,200-ton mass of steel is sure to follow on its 58 steel wheels. Steam is generated by a very compact boiler also located beneath the bridge floor, and the stack will extend over 50 ft. in the air outside the bridge tower. Water will be taken at first from locomotive tanks, but a condenser is talked of. The engine-room will be furnished with an indicator showing the position of the bridge and with signals for necessary communication with the shore. The bridge will be locked open by the same mechanism which holds it closed, the bearing-plates resting then upon a foundation afforded by three heavy trestle bents erected upon the fender-pier.

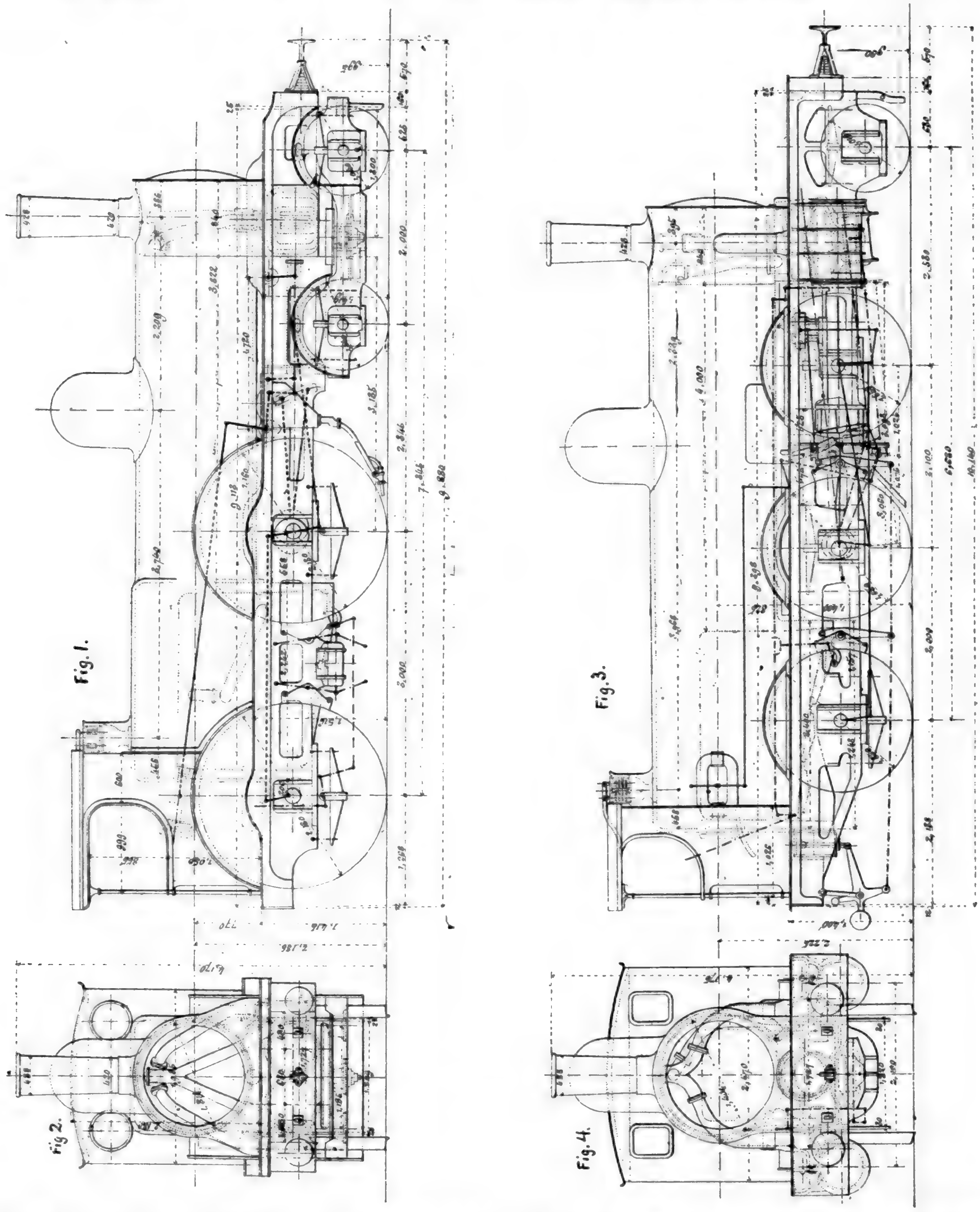


THE THAMES RIVER BRIDGE.

The signaling mechanism for the bridge will be governed from a cabin erected in the bridge tower, and will be the interlocking system of the Union Switch & Signal Company, with electric safeguards which prevent the movement of the switches or signals after a train has entered the section protected. There will be nine working levers, with additional space for others as required, and they will control two signals in each direction, the derailing locks and switches and the rail-locks for the ends of the draw-span. The signals are of the ordinary semaphore form, swallow-tail blade for distant signal and the square-ended blade for the home signal. On the New London side the distant signal is located 1,740 ft. from the end of the draw. The home signal is 710 ft. from the end of the draw and the derailing switch 660 ft. from the end of the draw. This line is of an average grade of 38 ft. rise to the mile approaching the bridge. On the eastern approach the derailing switch is 760 ft. from the end of the draw, the home signal 50 ft. farther, and the distant signal 1,870 ft. from the end of the draw. These greater distances have been taken on account of the down grade of 42 ft. to the mile in approaching the bridge from the east.

The last movement of the signalmen before allowing the bridge to be opened will be to unlock the planed ended

rails already described, on the outer ends of the draw. This is accomplished by an additional safeguard designed especially for this structure and known as the detector and rail-lock. The ends of the rails to be elevated carry a downward projecting bolt, which can enter its hole only



when the rails are down in their channels and the track is continuous. Then the movement of a lever will move a bar extending underneath both tracks, which carries four bolts, one for each rail. These are machine fitted and enter the holes in the lug, locking the rail down into position. If the signalman is unable to throw these bolts, he knows at once that the end rails are not in place.

It will be seen that the signal and other safety arrangements are exceedingly complete, and that every possible caution has been taken against accident.

In this connection we have reproduced the cut which was published with the original description of the bridge, and which shows the position of the spans, the elevation of the piers, and the nature of the bottom upon which they were founded. The foundations required considerable work and really formed the most difficult part of the bridge,

FRENCH LOCOMOTIVES AT THE PARIS EXPOSITION.

THE Exhibit of the Northern Railroad Company of France, at Paris, includes two large locomotives, the first of which is an express passenger engine, having four coupled driving wheels and a four-wheel truck. This type of engine has been in use on the road for a number of years with very excellent results for passenger service, but the present engine differs slightly in details from those at first adopted. The differences are not important, however. This engine is shown in figs. 1 and 2.

While the general type is that of an American locomotive, it differs from the class common in this country in having the cylinders placed inside, and in the use of the crank axle. Other peculiarities which will be noted are the plate frame and the arrangement of the exhaust nozzle. The steam-chests are placed at the side of the cylinders instead of on the top, but are outside, thus reversing the common English practice, which is to place the steam-chests between the cylinders. They are very slightly inclined from the horizontal.

These engines are provided with a steam driver-brake. They are also provided with a vacuum-brake, which is the type in use on this road for passenger trains.

The general dimensions of this engine are as follows :

Diameter of boiler barrel	1.250 meters.	(4 ft. 1.21 in.)
Length of fire-box	2.020 "	(6 " 7.53 ")
Width " " "	1.012 "	(3 " 3.84 ")
Number of tubes	208	....
Diameter " "	0.045 meters.	(1.77 in.)
Length " "	3.822 "	(12 ft. 6.47 ")
Heating surface, fire-box	11.000 sq. m.	(118.41 sq. ft.)
" " combustion chamber	2.800 " "	(30.14 " ")
" " tubes	97.000 " "	(1,044.14 " ")
" " total	110.800 " "	(1,192.09 " ")
Diameter of driving wheels	2.130 meters.	(6 ft. 11.86 in.)
Diameter of cylinders	0.480 "	(18.90 ")
Stroke	0.600 "	(23.62 ")

The total weight of this engine in service is 43.2 tons, of which 16.3 tons are carried on the truck, 14.6 tons on the main driving axle, and 12.3 tons on the rear or coupled axle.

The other engine exhibited by this Company is a compound locomotive, of what we should call in this country the mogul pattern, having three pairs of driving wheels coupled and a bearing axle forward. This engine is shown in figs. 3 and 4. The high-pressure cylinder is placed inside, in the smoke-box, with the steam-chest underneath, and is coupled to the main driving axle by a crank. There are two low-pressure cylinders, which are placed outside with the steam-chests on top, and which are also coupled to crank-pins on the main driving wheels. The high-pressure cylinder has a double valve, by which the admission of steam and its passage into the low-pressure cylinders is regulated. There is also a special valve provided, by which steam can be admitted directly from the boiler to all three of the cylinders, in case a special effort is desired in starting the engine on a heavy grade. The valve gear is of the Walschaert type.

The general dimensions of this engine are as follows :

Diameter of boiler barrel	1.346 meters.	(4 ft. 5.00 in.)
Length of fire-box	2.130 "	(6 " 11.86 ")
Width " " "	0.962 "	(2 " 1.88 ")
Number of tubes	208	....
Diameter of tubes	0.045 meter.	(1.77 in.)
Grate area	2.091 sq. m.	(22.51 sq. ft.)
Heating surface, fire-box	9.300 " "	(193.11 " ")
" " tubes	104.500 " "	(1,124.87 " ")
" " total	113.800 " "	(1,317.98 " ")
Diameter of driving wheels	1.650 metres.	(5 ft. 4.96 in.)
" leading wheels	1.010 "	(3 " 3.76 ")
" high pressure cylinder	0.432 "	(17.01 ")
" low-pressure cylinders	0.500 "	(19.69 ")
Stroke of all cylinders	0.700 "	(27.56 ")
Total weight of engine in working order		52 tons.
Weight on leading axle		7¾ "
" " forward driving axle		14¼ "
" " main driving axle		15¼ "
" " rear driving axle		14¾ "

This engine has been in service about two years, and so far has given very excellent results. It is used for working mixed traffic on some of the lines of the Northern road, and has also been used for some time in running freight trains. In both classes of service a considerable economy in fuel is reported.

In the accompanying illustrations (taken from the *Revue Generale des Chemins de Fer*) fig. 1 is a longitudinal view and fig. 2 a front view of the passenger engine ; fig. 3 is a side or longitudinal view, and fig. 4 a front view of the compound engine.

SHIP-BUILDING ON THE PACIFIC COAST.

(Extract from article by Lieutenant-Commander F. P. Gilmore, in *Proceedings* of the U. S. Naval Institute.)

THE *Sitka*, a small paddle-wheel vessel, was the pioneer steamer in the waters of the Pacific Coast. She was built in the town of that name in Alaska, in 1847, was 37 ft. in length, with 9-ft. beam, and 3½ ft. depth of hold. She was brought to San Francisco on the deck of a sailing-vessel, made her trial trip on November 15, and, after short runs to Sonoma, Santa Clara, and Sacramento, she, after the discovery of gold, ran under the name of the *Rainbow* on the Sacramento River, and was finally lost in a gale while at anchor. The wreck of the *Beaver*, the first steamer that came into the Pacific from the south, now lies opposite Vancouver. She was also a paddle-wheel boat, and was for years in the service of the Hudson Bay Company in the Sound. She is not such a wreck but that she could be easily repaired.

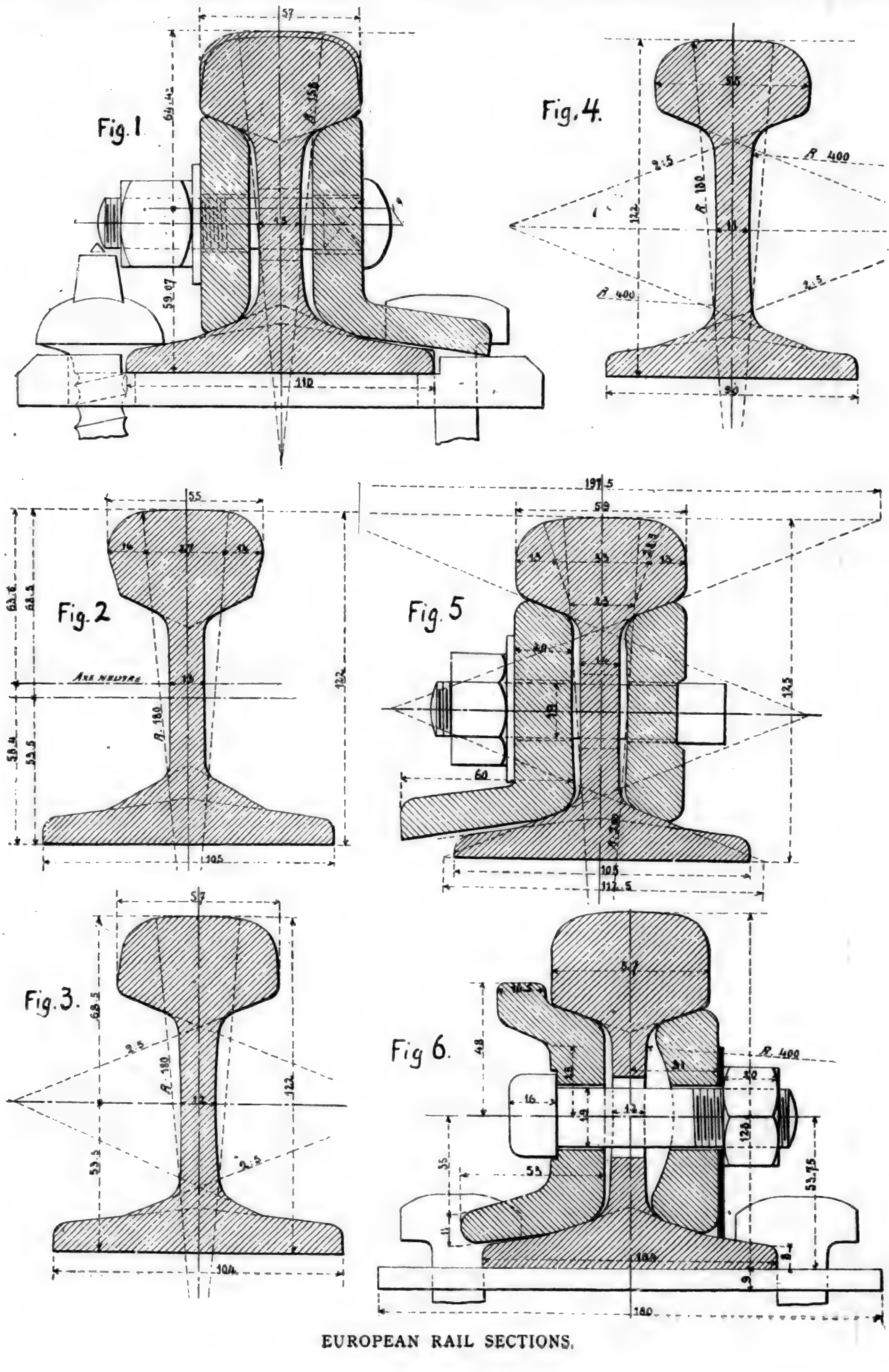
With the exception of the Union Iron Works of San Francisco, all the ship-building yards on the coast are for the construction of wooden vessels, the Union Iron Works having the only plant for building deep-sea vessels of any size of iron or steel.

The abundance and accessibility of the timber on Puget Sound, with its tranquil waters, makes it a paradise for wooden ship-builders ; and with its coal and iron mines, it promises to be the same for the steel ship-builder. The durability of the Puget Sound timber was discovered during its extensive use for repairs. Its advantages are its great length, size, and lightness, and the tenacity with which it holds iron fastenings. Its cheapness was an offset against the high price of labor. There is now on the coast a large fleet of wooden vessels unrivalled for the lumber trade, and which challenge comparison with any other lumber fleet in the world.

Hall's shipyard, opposite Seattle, is the only permanent one located on the Sound. The largest vessel yet built was the bark *Hesper*, of 695 tons gross, but the yard has the capacity for building any sized wooden ship. A steamer, intended for trade on the Sound, was lately launched at Tacoma. Small vessels are built at many places along the coast, principally on the Columbia and Willamette, and at Humboldt, Coos Bay, and Benicia.

A large industry in San Francisco is the building of steam schooners for traffic along-shore. They are most of them engined, and many of them contracted for by the Fulton Iron Works. This firm has placed engines varying from 500 to 800 H.P. in about 80 of these vessels. The ferry-boat *Encinal* has engines of 1,200 H.P. Another great interest in San Francisco is the steam whaling fleet. Out of 47 vessels sailing from that port in 1888, 25 are owned there. In 1884 the catch of the six steamers built and equipped in San Francisco was greater than that of the entire Eastern fleet of 20 vessels sailing from the port, and including their two steamers. The whaling fleet gives employment to 1,800 men. What a nursery for a naval force !

As early as August, in 1885, the Union Iron Works made proposals to build any of the cruisers then authorized by Congress. In that year was launched from this yard the *Arago*, the first steel steamer built on the Coast for deep-water cruising. She is of 827 gross, is 200 ft. long, with 30-ft. beam, and a draft of 16 ft., and with engines of 450 H.P. The Fulton Iron Works claim to have built at an earlier date a small iron steamer, the *Sucre*, of 50 H.P.



EUROPEAN RAIL SECTIONS.

Up to 1885 the vessels built on the Coast were of wood. Since that date the Union Iron Works have built and launched the *Charleston*, 3,200 tons; the *Pomona*, 1,246 tons; the *Premier*, 1,080 tons; and the tugs *Collis*, *McDowell*, and *Active*, all of steel. The *San Francisco*, of 4,000 tons, is on the blocks, and the contract awarded for the coast-defense vessel authorized by the last Congress. The engines of these vessels were manufactured at the machine shops of the works, the steel, castings, and heavy forgings being made at the Pacific Rolling Mills. The launching of the *Charleston* marked a new era on the Coast, the inauguration of a great ship-building trade. Encouraged by a well-considered policy on the part of the Government, the wooden fleet on the Coast, the vessels that are to carry our trade in the Pacific, and the cruisers and battle-ships of the Navy, can be built as expeditiously and as well as at any other yard in the country or world.

During the year 1888 there were built at and about San Francisco 59 sea-going vessels, mostly for the coasting trade. The climate is very favorable for the ship-builder. During the winter of 1887–88, but 10 days were lost on the *Charleston* because of the weather. Steel plates are never too cold to work or handle, nor in winter is half the time of a riveter lost while he blows his fingers. The summers are cool, with no rain.

The *Pomona* was contracted for with the Union Iron Works on September 14, 1887, and launched May 26, 1888. The *Corona* was contracted for with an Eastern firm, October 29, 1887, and was launched August 4, 1888. The former vessel cost $200,000, the *Corona* to cost $188,000, or $198,000 delivered in San Francisco. The *Pomona* is of 1,246 tons gross, 951 net, and the *Corona* is of 1,492 tons gross and 966 net. The *Pomona* has two boilers, and the *Corona* four, and both vessels have triple-expansion engines. The *Pomona* will carry as much cargo as the *Corona*, and runs on 20 per cent. less fuel, and she is the faster ship.

The company ordering these vessels had the use of the *Pomona* while the *Corona* was steaming around to the Pacific, and that trip is considered equal to a year's wear and tear in the regular work of the vessels. The above is cited only to show that the ship-builder on this coast can hold his own in material and workmanship.

Some interesting data was handed the writer lately of a steamer built when Thornycroft's reputation was young, and the fast torpedo-boat in its infancy. In 1876 the specifications for the iron steamer *Meteor*, to run on Lake Tahoe, called for a speed of 20 miles per hour. She was built at Marysville, Cal., and all material and machinery were teamed over the mountains. There was no previous record of a vessel's steaming 20 miles per hour. The *Meteor* is 64 ft. 6 in. long, with 10-ft. beam, and a draft of 5 ft. aft and 3 ft. 1 in. forward, and a depth of hold of 5 ft. She is of 19.5 tons displacement, with fuel and 12 passengers on board, and is divided into water-tight compartments. The boiler is of steel, locomotive type, and carries 150 pounds pressure. The engines are one pair inverted cylinders, 10 in. diameter and 12-in. stroke, and weigh 2,600 lbs. with all fittings. The propeller is of brass, three-bladed, and finished all over. The *Meteor* made 21 miles per hour repeatedly over a measured mile, and from Glenbrook to Tahoe City she made 12 miles in 38 minutes, or 18.9 miles per hour. The engines made between 270–280 revolutions, and were designed and built by W. R. Eckart. The largest torpedo-boat afloat, in 1881, was built by Thornycroft for the Danish Government. She was of 55 tons displacement, with a coal capacity of 10 tons. At full speed, as shown on trial as well as during a three hours' run on measured miles, she made 20 knots per hour.

What is most needed in San Francisco is an abundant and cheap supply of good coal. With this, even with the high price of labor, the shipyards here could compete with any in the world. Most of the coal comes from Australia and British Columbia. Mines are being discovered and opened at many places along the northern coast, and some reported very valuable are about being opened at Kenai in Alaska. The Kenai Company claims it can place coal in San Francisco at $3.50 a ton, with 10 per cent. profit. Of the 1,400,000 tons of coal received at San Francisco in 1888, nearly 700,000 tons were foreign and almost the whole of it transported by water. The importance of the absolute control of Puget Sound and the Columbia River, as well as the development of lines of supply between the two, needs no argument. At present, in case of war, San Francisco would be without coal at once, even if the whole coast were fortified. Efficient naval and merchant vessels are absolutely necessary.

The material for the steel vessels built on the coast is made and shaped at the Pacific Rolling Mills, and for quality is unexcelled. With its already extensive plant it would not be difficult for this firm to erect hydraulic forges that would turn out any shape for ship or gun. But it would have to be under a contract with the Government for a large enough order, running over some years, to remunerate the firm for its outlay. There are other firms in San Francisco ready to contract for building marine engines and boilers of any size. There is an abundant supply of good iron ore on Puget Sound. But in 1888 there were imported from Great Britain to San Francisco 18,393 tons of pig iron, against 2,037 tons from the Eastern States, and 1,940 tons from the Coast furnaces. The principal reason for this is that grain ships bring the iron for ballast. The Port Townsend ore is excellent, and there is also good Bessemer ore in California.

Besides the Government docks on the coast at Victoria and Mare Island, there is a large dry-dock at Hunter's Point in San Francisco, and the new hydraulic dock at the shipyard of the Union Iron Works.

THE WEAR OF STEEL RAILS.

[Condensed from a paper prepared by M. Louis de Busschere, Chief Engineer of the Belgian State Railroads, for the International Railroad Congress.]

ONE of the subjects for special consideration at the present meeting of the International Railroad Congress at Paris, was the Wear of Steel Rails, upon which a large number of reports have been submitted by the different railroads connected with the Congress. The present paper is intended to give a summary of the experiences represented in these reports and to cover the question as far as possible from the observations at hand. As will be seen, however, these observations have not been carried out on a sufficiently extensive scale, nor reported in a sufficiently systematic manner to enable the writer to reach any definite conclusions. A continuance of the observations on a larger scale, with reference to the subject and the next meeting of the Congress, is recommended.

In connection with this report, the *Bulletin* of the Commission of the Congress gives the standard rail sections in use on a number of important European lines, and it has been considered of interest to reproduce these sections in the accompanying plates. The table below shows the roads represented in the illustrations.

RAIL SECTIONS.

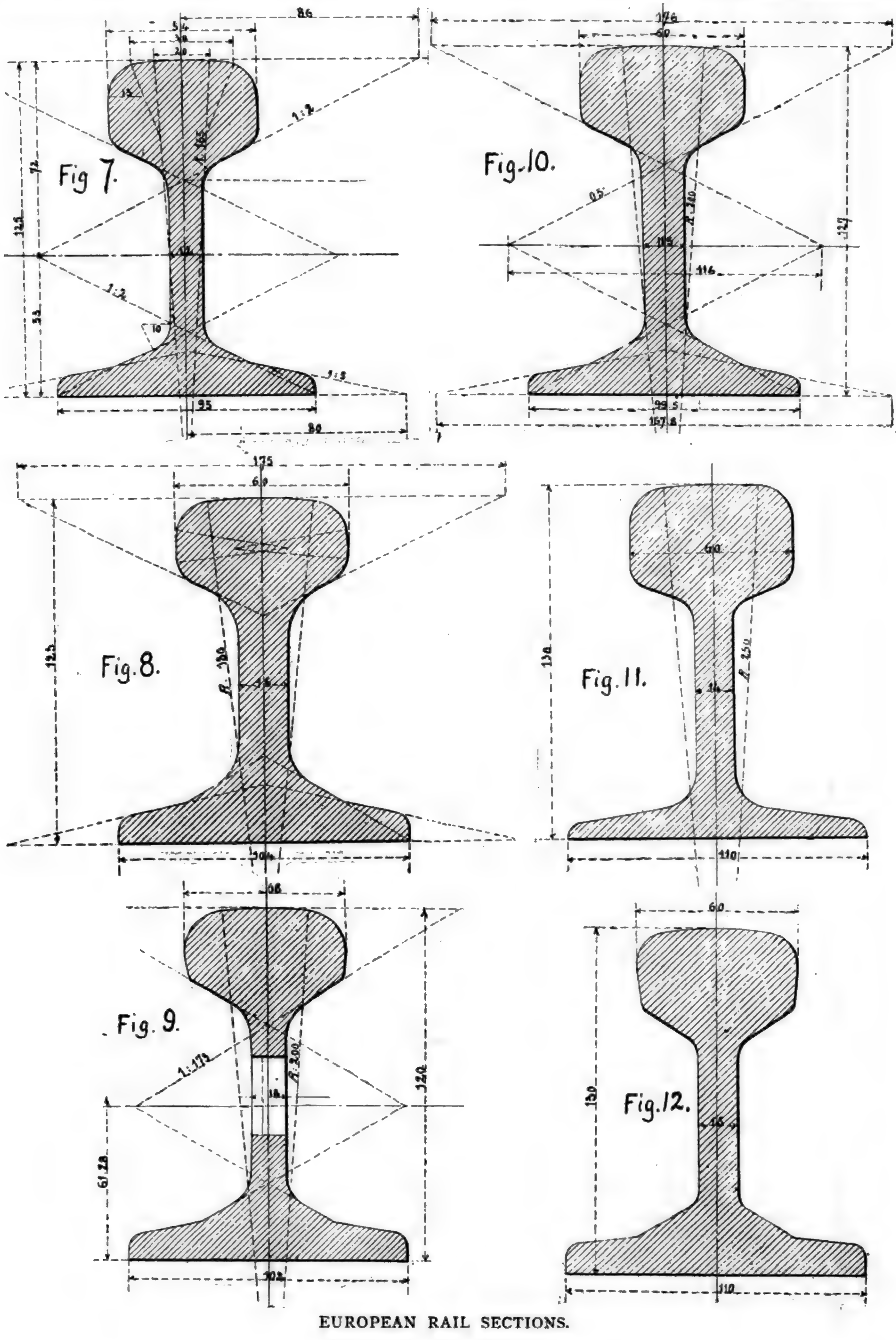
Fig. 1.	Kaiser Ferdinand Northern Railroad (Austria).
Fig. 2.	Austrian Northwestern Railroad, No. 1.
Fig. 3.	" " " No. 2.
Fig. 4.	" " " No. 3.
Fig. 5.	Austrian State Railroads.
Fig. 6.	Hungarian State Railroads.
Fig. 7.	Andalusian Railroad (Spain).
Fig. 8.	Belgian Grand Central Railroad.
Fig. 9.	Netherlands State Railroad.
Fig. 10.	Swiss Southwestern Railroad.
Fig. 11.	Netherlands-Rhenish Railroad.
Fig. 12.	Holland Railroad Company.
Fig. 13.	Riazan-Koslow Railroad (Russia).
Fig. 14.	Rostof-Woronege Railroad (Russia).
Fig. 15.	Belgian Northern Railroad.
Fig. 19.	French Government Railroads.
Fig. 20.	Midland Railroad (France).

TIRE SECTIONS.

Fig. 16.	Kaiser Ferdinand Northern Railroad (Austria).
Fig. 17.	Austrian Northwestern Railroad.
Fig. 18.	Hungarian State Railroads.

NOTE.—All measurements on the plates are in millimeters. The engravings are all made to the same scale—one-half full size.

The rail sections given, with the exception of the two



EUROPEAN RAIL SECTIONS.

shown in figs. 19 and 20, are all of the Vignoles type, which is commonly used in this country. The double-headed rail has a number of representatives, especially on the French and English lines, but most of these have been omitted as being of little interest here, the two given being selected for reproduction as types of the general form of that class of rail.

The comparison of the sections of rail in use on so many prominent railroads in Europe with those used in this country will be an interesting one, which there is not here space to give in any detail. One point which may be especially noted, however, is that the European railroads do not favor sharp corners, and that the radius of the curve joining the top surface of the head to the sides is in all cases large. Other points, both of resemblance and of difference, will also attract attention. It is to be regretted that sections of the joints used, do not in all cases accompany those of the rails, which would have afforded an opportunity for other interesting comparisons.

The greater part of the steel rails to which the report refers are Bessemer steel; for while rails of crucible steel and of puddled steel have been to some extent used in Europe, the Bessemer and allied processes of steel-making have met with most favor there as here.

The tables given by the different companies do not give, in general, data upon which can be based any general averages. As a specimen of careful observations, the following table of general results obtained on the Kaiser Ferdinand Northern Railroad may be of interest:

Conditions of Track.	No. of trains corresponding to a wear of		No. of tons corresponding to a wear of	
	1 mm. in height.	1 sq. mm. in surface.	1 mm. in height.	1 sq. mm. in surface.
Tangent, brakes not used	100,022	2,481	39,962,000	1,068,000
Tangent, brakes used	36,802	948	20,271,000	522,000
Curves, brakes not used	81,052	2,126	34,529,000	895,000
Curves, brakes used	31,784	767	17,931,000	430,000
Average for sections on tangents	77,252	2,097	35,038,000	....
Average for sections on curves	62,897	....	28,430,000	....
General average, all sections	69,460	....	31,451,000	....

The wear given is the average of the two rails in the track, and the sections on which the observations were taken are all double track.

The following table shows the result of some interesting observations made on the Austrian Northwestern Railroad with relation to the effect of different kinds of supports on the wear of the head of the rail. In this case several sections were included in the observations, and the conditions on each are given:

Kind of Support.	No. of trains corresponding to a wear of		No. of tons corresponding to a wear of	
	1 mm. in height.	1 sq. mm. in surface.	1 mm. in height.	1 sq. mm. in surface.
Longitudinal sleepers:				
1. Tangent and level	44,500	1,068	13,510,000	324,000
2. Level, curve 1,000 m. radius	43,750	925	13,160,000	283,000
3. Grade of 0.2 per cent., part tangent, part curve	41.300	948	12,350,000	290,000
Iron cross-ties:				
Level, curve of 400 m. radius	40,000	1,009	12,050,000	306,000
Wooden cross-ties:				
1. Curve of 380 m. radius, grade 0.75 per cent	42,417	1,193	11,760,000	283,000
2. Tangent, grade 1 per cent	37,289	923	10,310,000	256,000

From this it appears that the wear of rails carried on wooden ties is somewhat less than on metal ties. These single observations, however, can hardly be considered as settling this point.

The observations made on the reports submitted by the different railroad managements, while many of them are of interest, are too long to be fully given here. The general summary and the conclusions based on these reports are, however, given below very nearly in full as written by M. de Busschere.

To sum up and review all the reports which have thus been submitted to the Congress and to arrange them in a systematic order to permit of their proper discussion is no easy task. The circumstances under which the observations were taken differ very much, and unfortunately the local conditions are not completely given in many cases where there has been unusual wear. These cases of abnormal wear are often to be attributed to complex causes, the action of which it is difficult to measure.

We will therefore limit ourselves to speaking of those general causes the influence of which seems to be established by the greatest amount of evidence.

An important question presents itself at the outset. Is it best in the observations to consider the wear in height or the wear in surface?

This point settled, is the wear to be determined by the number of trains or by the number of tons passing over the rails?

In this it must be understood that account is to be taken alone of the wear of the rail due to use and not of that resulting from rusting, oxidation, or other chemical action. This question decided we may proceed to examine the different points affecting the life of the rail.

1. *Chemical Composition.*—The French companies use a hard steel, according to the tables which have been presented. The wear of the rails on the Paris, Lyons & Mediterranean Railroad on a tangent and a level may be averaged at 1 mm. for 110,000 trains, or 30,000,000 tons; on the Eastern Railroad—where the rails weigh only 30 kgs. per meter—the wear is 1 mm. for 100,000 trains and 20,000,000 tons; on the Orleans Railroad the wear seems to be 1 mm. for 93,000 trains. With relation to the last-named road, however, it may be remarked that we cannot apply to so extended a system the results of observations made on a single system. Bearing this in mind it may be said that these figures do not differ greatly as to the number of trains.

On the Austrian Northwestern Railroad the steel also has a high proportion of carbon, but there is a smaller quantity of manganese; on this road the wear on a tangent and a level is 1 mm. for 44,500 trains.

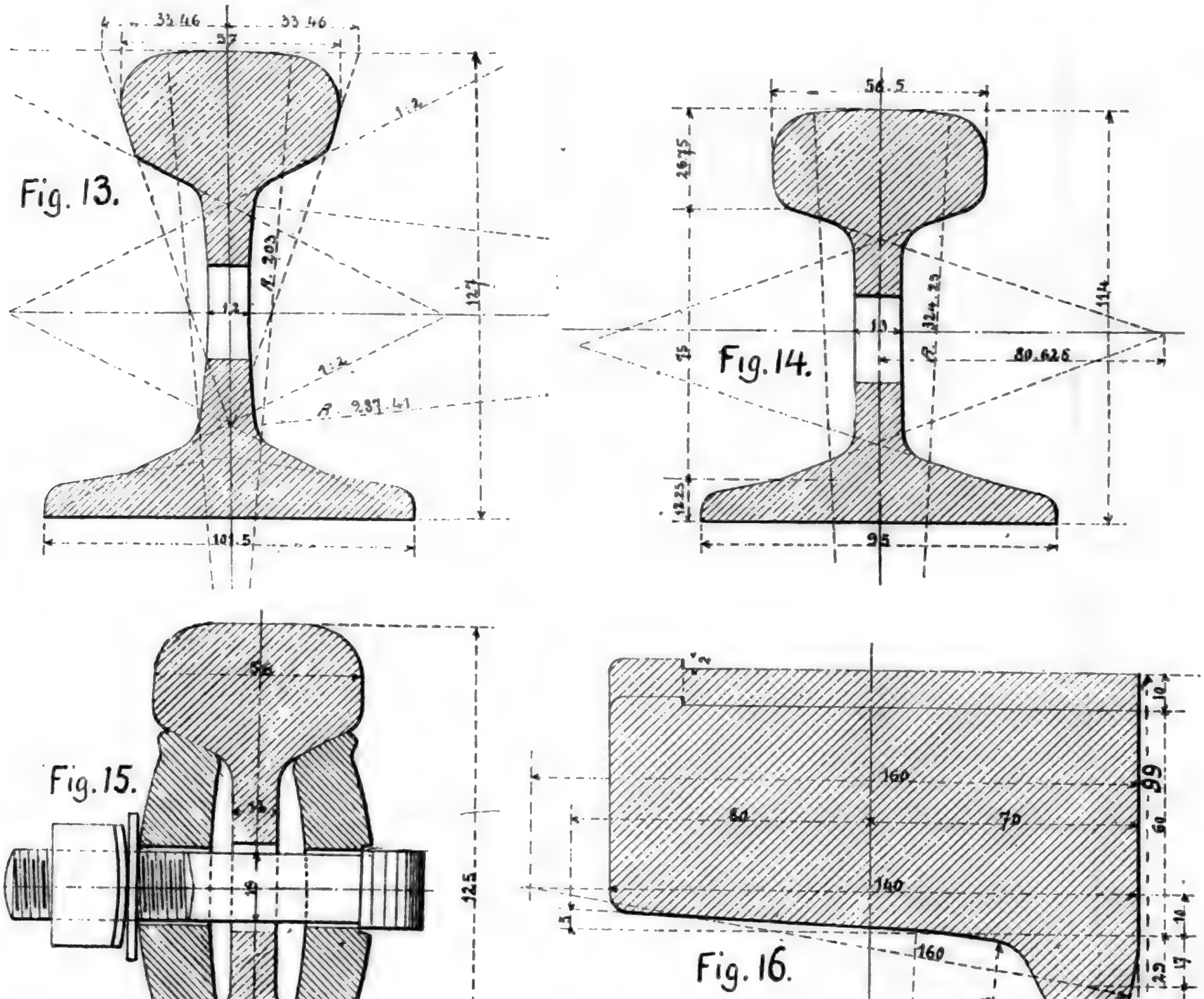
On the Netherlands State Railroad the rails which have given the best results contain 0.366 of carbon and 0.637 of manganese, and the average wear reported is 1 mm. for 32,400 trains.

The Austrian railroads, outside of the Northwestern, use a mild steel. On the Kaiser Ferdinand Northern Railroad the wear on a level track, especially on single-track lines, is much greater, whether we take the number of trains or the tonnage. The resistance to wear on the Hungarian State Railroads is considerable, but here again it is impossible to make a general average from a single observation taken on so extensive a system.

On the Netherlands-Rhenish Railroad the steel contains little carbon but a high proportion of manganese. The resistance to wear here, taking the tonnage as a basis, is 1 mm. for 26,000,000 tons.

Manganese is one of the hardest metals and will even cut glass. Iron comes only fifth among the metals in point of hardness. Manganese, then, should have the effect of making the iron harder. On the other hand, it oxidizes rapidly when exposed to moisture and decomposes water with a rapidity which increases with the temperature. It must, therefore, be considered that in Holland, where the climate is very damp, a high proportion of manganese will exercise a considerable influence upon the wear of the rail. These observations coincide with the experiments made and the theories formed by M. Couard and M. Grüner.

2. *Methods of Manufacture.*—In France the rails used are nearly all of Bessemer steel, and it is generally considered that these are superior to the Martin steel. In Austria the steel-works generally use the Thomas process, by which manganese, phosphorus, and other foreign elements are taken out. These observations, however, are not sufficient to show all the elements which may cause the



EUROPEAN RAIL AND TIRE SECTIONS.

quality of the rails to vary. For this purpose very careful observation is necessary. It is well known that rail steel may differ slightly in quality in two successive heats, and that sometimes even the metal in the same rail is not homogeneous. This has often been indicated by experiments made on test-pieces cut from rails of different manufacture.

3. *Size of Rails.*—The reports received have been too indefinite on many points and too few in number to permit us to indicate exactly the influence on a rail of the following points:

1. The weight of the rail.
2. Its modulus of flexion.
3. Its length and the number of supports.
4. The section of the head.
5. The proportion of the three parts—head, web, and foot.
6. The nature of the supports.
7. The system of joints, supported or suspended.

We may nevertheless, from the statistics at hand, reach certain conclusions:

1. Other conditions being equal, the resistance of the rail to wear increases with the resistance to vertical strains.

the brakes must be used to regulate the speed of the trains.

When on a double track a rising grade succeeds to a falling one, we find almost always greater wear at the bottom of the falling grade and at the foot of the rising than on the level track which separates them. This increase of wear would very naturally result from the fact that the engineer would increase at such a point the speed of his train in order to attack the rising grade to the best advantage. This conclusion is supported by the observations made by the German Railroad Union and on the Hungarian State Railroads. The wear of the rail on the single-track lines appears to be influenced very much more by the grade than on a double-track line.

5. *Influence of Curves.*—The influence of curves on wear is shown by the observations made on the Austrian Railroads with considerable care. It increases as the radius of curve decreases. Nevertheless, its absolute value is not great when we consider the wear in height only without taking account of the lateral wear. The wear in height on the inner rail is always very much greater than on the outer rail, which is usually elevated. It would have been very interesting to secure exact statements of

Fig. 19.

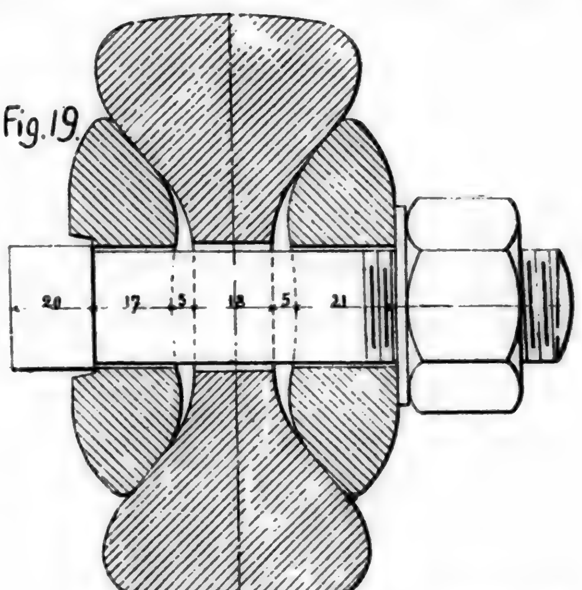
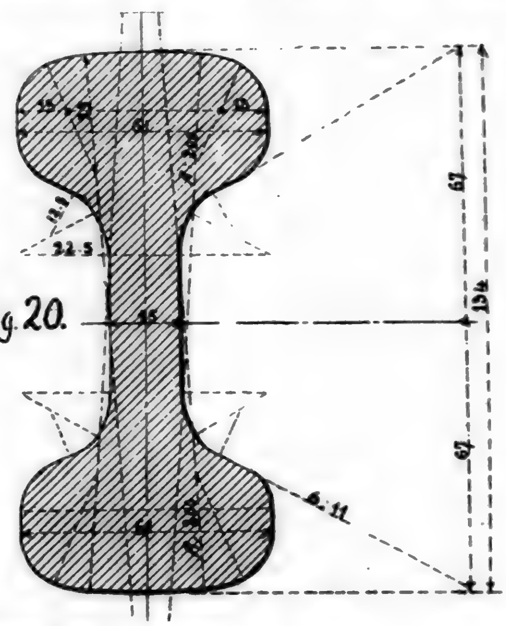


Fig. 20.



EUROPEAN RAIL SECTIONS.

2. That wooden ties seem better as far as the wear of the rail is concerned.

3. It is probable that the section or form of the head has a considerable effect on the surface wear; but in order to reach a proper decision on this point, a great number of comparative tests must be made and the sections of a large number of rails must be taken.

In the figures given in the report of the German Railroad Union for 1879–84, diagrams of 140 different rail sections are given, and of these several show considerable side-wear, as shown in the following table:

Form of head.	Total number.	Showing much lateral wear.
Rectangular....	68	13
Narrower at top....... ...	60	13
Narrower at base..........	12	4

From this it appears that the third form, that is the head narrower at the base, presents the least advantages. The influence of the inclination oft he rails, of the coning of the tires, and of the greater or less differences in hardness of the steel used for the tires and for the rails, can hardly be drawn from the observations of which we have the results.

4. *Influence of Grades.*—The influence of rising grades on a double-track line seems to be very slight, except in those cases where the grades become very heavy and require the use of very powerful locomotives to draw the trains.

On the other hand, the influence of falling grades is very marked, especially where it passes a certain limit so that

this difference in the wear, so that we could ascertain to what degree it varies with the super-elevation of the outer rail; but the observations are not sufficiently numerous for that purpose and more careful experiments must be waited for.

6. *Wear in Stations and Yards.*—This, as might be expected, is usually very much greater than on the open road. This proceeds not only from the greater number of passages over the rail, but from the constant use of brakes, and the question in many respects is similar to that of the wear on heavy grades where brakes are frequently used. It may be assumed safely from the evidence which we have that the wear varies with the frequency of the action of the brakes. It is to be noted that it is greater where continuous brakes are used than where the old hand-brakes are still employed. This result is a natural one, since when the brakes can be easily applied and at the will of the engineer, they will be much more frequently used.

7. *The Influence of Climate and Atmospheric Conditions.*—On this point again it may be said that observations are not yet numerous. It also appears that in Holland the wear is more rapid than anywhere else, and this seems to be due in part to the great dampness of the atmosphere of that country.

It may also be said that the purity of the air has considerable influence upon the wear of steel rails. If, for instance, we take three different sections of the Belgian State Railroads where careful observations were made, we find that on one section there has been a wear much

more rapid than on others of nearly equal traffic. Now this section passes through a country in which there are numerous iron furnaces, steel works, coke-ovens, and other factories, from which great quantities of smoke and gaseous matters are constantly given out, and there can be no doubt that this exercises a certain rusting or oxidizing action upon the rails.

8. *Ballasts.*—The influence of the ballast on the wear of the rails, while not yet exactly determined, appears to be very considerable from such reports as have been received relating to this point. It seems that with sand-ballast the wear is much greater than with stone or gravel. The probability is, that with sand-ballast very much the same action takes place as where sand is used to prevent the wheels of the locomotive from slipping—that is, little particles of sand are blown upon the rail and a greater degree of friction results by which the rail is worn or cut away. Some remarkable figures have also been presented showing that the wear is very much greater where cinders or broken slag are used for ballast; but further observations are needed on this point.

9. *The Influence of Tunnels.*—Such figures as have been presented, showing the increase of wear in tunnels, may be explained by the fact that there is generally a great deal of dampness in tunnels, especially those which are long and not very well ventilated. There may be, moreover, in these some chemical action from the smoke given out by the engines which is long retained in contact with or near the rails. On the other hand the statistics of the Gothard and Simplon tunnels do not indicate a very high or unusual amount of wear.

Finally, it may be said that as to one point which has been raised in discussion, that the resistance to wear of the rail increases with its age, the observations presented do not at all agree. Some of the statistics of the German Railroad Union seem to indicate that this assumption is true, but further light is needed on this point.

The observations made so far have referred entirely to the wear of the head of the rail, that is, that part of the rail upon which the wheels act directly. Very few statistics have been received concerning the wear of the web. This wear must result chiefly from rusting or from atmospheric action, although some of the observations made by Price Williams on rails placed at the Crewe Station in England, where the traffic was extremely heavy, would seem to show that the depreciation and wear extended to a certain degree throughout the whole rail. Aside from this, at the ends of the rails the fish-plates will cut more or less into the inclined faces of the head and the foot of the rail against which they bear. The hammering or abrupt action produced by the passage of the wheel over the joint will necessarily produce a succession of slight shocks or frictions. These will increase in effect as the speed of the train and the load carried by the wheels increase. Whether there is any influence exercised on this wear by the use of a greater or less fishing-angle, is not at present apparent.

As to the wear of the foot or base of the rail, very few observations have been presented, as most companies do not seem to have considered it of much importance to make careful observations on this point. It may be said that the foot of the rail is very often covered with ballast, so that consequently its wear does not appear at all times, and is seen only when the track is reballasted or the rail removed. Moreover, to ascertain whether there has been any wear of the foot will generally require very careful observations.

On the Belgian State Railroads it is reported that on the lines of heavy traffic the base of the rail wears at the points of support at the rate of about 1 mm. per year. When there are chairs or plates between the rail and tie, the wear is more rapid, but the report does not show what the exact effect is. It is also stated that certain kinds of ballast corrode the base of the rail and cause a considerable wear.

It would appear from the observations made above that thus far we can only establish a few general laws. Very much better results will be obtained if the railroads connected with the Congress will establish numerous points for observation of the influence which different local circumstances and the different conditions of grade, curves, etc., etc., may have upon rails of the same form, weight, and conditions of manufacture. There should be also a general form agreed upon on which reports on the wear of rails should be made to the Congress, and this report should cover all the points which have been indicated, giving information which could be carefully analyzed, and will enable us after some years to determine finally the laws covering the wear of rails.

THE USES OF ELECTRICITY ON SHIPBOARD.

THE following extracts are from a very interesting paper by Mr. S. Dana Greene (late Ensign, U. S. N.), published in the latest number of the *Proceedings* of the United States Naval Institute. It will be seen that many of his remarks will apply to steamships for commercial purposes as well as to war-ships. After some general statements as to electric motors, the paper proceeds as follows:

I do not intend to go into the theory of the subject, but rather to try and show how and why electric motors can be advantageously substituted aboard-ship for many of the auxiliary steam and hydraulic motors with which our new ships are crowded. First, let me state briefly the two general classes into which successful electric transmission may be divided.

1. Where large units of power are transmitted over long distances (varying from 5 to 25 miles), and where the work to be done is concentrated in two or three units.

2. Where smaller units of power are transmitted over comparatively short distances for a large variety of purposes.

Ship-work comes under the second class, and it is by far the most common and widely used method of transmission. It is the system now used in all of our large cities, where central stations for the distribution of lights have already been established, and where the revenue to these stations from their *sale of power* is rapidly approaching, and will soon surpass that derived from the sale of *light*. Independent power stations are also being established, stations where nothing but power will be sold. These facts are sufficient to prove that the electric motor has passed the experimental stage, and that its superior reliability, economy, and efficiency are an established fact. Both the Army and the Navy are conservative where innovations or new devices are concerned, and properly so. The officers are charged with the expenditure of government moneys, and they have neither the authority nor desire to develop new commercial enterprises. It is their duty to take advantage of these new enterprises when they have proven themselves successful, and when they can be applied with advantage to either service. A bill was before Congress at its last session to appropriate a generous sum of money for the development of the electric motor for naval uses, and it is to be hoped that this action of Congress will receive the cordial approval and support of all naval officers.

The work required of the auxiliary engines of one of our latest type of vessels may now be divided as follows:

1. Steam, air and condenser pumps located in engine-room, both for main and auxiliary condensers.
2. Steam pumps for fire purposes, for pumping out the ship, washing decks, etc.
3. Steam reversing engines for each engine.
4. Steam-engine for jacking the engines.
5. Steam steering engine.
6. Steam capstan engines.
7. Blower engines for producing forced draught in the fire-room.
8. Ventilating engines for ventilating the living spaces below.
9. Hoisting engines. Under this head are included steam ash-hoists and hydraulic ammunition-hoists.
10. Steam winches about the decks for lifting heavy weights, swinging out boats, etc.
11. Steam or hydraulic training engines for large guns.
12. Steam-engines for driving the dynamos.
13. Steam-engines for working lathes, drills, etc., in workshops.

Taken together, these auxiliaries will aggregate 40 or 50 engines on a large ship, representing perhaps 200 H.P. The engines, however, are never exerting their maximum power at the same time; hence if the work were done by motors, not over 60 to 70 per cent. of this 200 H.P. (allowing liberally) would have to be provided for in the dynamo room.

Now I hold that the electric motor can replace every one of these auxiliary engines, and do so with a great saving in first cost and space occupied, and make the whole system of supplying auxiliary power cheaper, more efficient, simpler, and generally more satisfactory to every one.

It will be seen at a glance that it is necessary to distribute steam to every one of these auxiliary engines. Even the hydraulic machinery, very complex in itself, must have a steam-engine to operate the compressing pumps. The engines are scattered all over the ship, from the capstan engine in the forward compartment to the steam steerer in the after compartment. To each engine it is necessary to run a separate steam and exhaust-pipe. These pipes, varying from 3 in. to 5 in. in diameter, must pass through water-tight bulkheads, at each one of which a water-tight packing joint must be made; they must bend and twist and turn so as to take up as little room as possible, out of harm's way; they must be heavily lagged wherever they pass through officers' or men's quarters; finally, expansion joints must be provided between rigid bulkheads, or there will be constant leaks at all joints and flanges or else buckling of the pipes. On board the *Atlanta*, for the first year after the ship went into commission, a gang of men were kept busy repairing leaks and breaks in the steam piping. On a ship like the *Maine* or *Texas*, the piping for the auxiliary engines will run up into the *miles*. The first cost of laying the pipe is enormous; it requires constant attention to keep it in good condition, and even when in good condition, the pipes are hot and cumbersome and the engine dirty and noisy. If repairs are to be made to engines, they must be made by a machinist; a machinist is necessary to operate the engines. If a steam-pipe should be struck by a shot in action (and it would be a hard matter *not* to strike one), there would be a rush of steam at 80 or 90 lbs. pressure within the compartment where the shot entered, which would probably seriously injure or demoralize the men in that neighborhood. The engine connected to that pipe (and it might be the steam steerer) would probably be useless during the rest of the fight.

As to the efficiency of these auxiliary engines, it is probably very low, taking into consideration the fact that there is necessarily much loss in the pipes from radiation, condensation, and back pressure, and that small, simple engines of the type necessarily used are notoriously wasteful of steam and uneconomical in operation.

The mechanical applications made necessary by the use of auxiliary steam-engines deserve notice. The steering engine is located at the stern of the ship, where it can operate directly on the tiller. The steering of the ship must, for obvious reasons, be done from forward. The usual method of operating the valve of the steam steerer from the pilot-house is to run a line of shafting from one point to the other, the shafting being operated either by hand or by another engine in or under the pilot-house. On board the *Atlanta* this shafting passed along overhead on the gun-deck, thence down to the berth-deck, and through the ward-room, until it finally reached the steering engine. In this distance it made no less than *eight* changes of direction, necessitating 16 bevel gears beside clutch couplings for each of the three wheels. A 1-lb. Hotchkiss shot coming in on the gun-deck would knock the shafting out of line in a second, and the ship would then have to be steered by word of command along from the conning tower to the steering compartment. Another example of the cumbersome mechanical devices made necessary by the use of steam is the gun-training engine for the 8-in. B. L. R. The engine for it took up so much room that it could not be put on the gun-carriage. It was, therefore, put in a room by itself on the orlop-deck, and connection was made to the carriage by a vertical shaft running up through two decks. The amount of power lost in friction and change of direction is great, and the executive officer's room was spoiled by having an ugly shaft running down through it. I mention these particular cases not to criticise the devices in themselves, but to show the non-adaptability of any system for ship use which makes such devices necessary.

Now, in what respects will the application of electricity be an improvement over the present system? Instead of the steam and exhaust pipes, 4 in. or 5 in. in diameter, being run all over the ship, we have in the first place our main conductors, running fore and aft, and secure below the water-line from shot and shell. The mains are perhaps ½ in. in diameter instead of 4 in. In each compartment where a motor is located, vertical branch lines are run to the motors and lights. These wires can be bent around corners or taken over or around obstructions at will. They require no elaborate water-tight slip joints at bulkheads; a half-inch hole with a small stuffing gland inserted is all that is needed. They require no lagging to make living quarters inhabitable; no expansion joints to prevent buckling of the bulkheads or leaks in the wires. The branch lines being run vertically, to a certain extent at least, present a minimum target to an enemy's shot. If a wire is shot in two, there is nothing to damage the man or create a panic among them; the most ignorant man aboard-ship by a single twist can splice the break in a few seconds, and the motor will run as well as it did before. In fact, nearly every objection raised to steam-pipes is eliminated. When we come to the motors, the advantages are equally marked. For equal horse-powers the electric motor occupies less than half the space of the steam-engine and weighs less. There is no heat or escaping steam about the motor. Any "idler" can operate it by opening or closing a switch; and beyond an occasional filling of self-oiling bearings and cleaning of the commutator, the motor runs itself. The motion is *rotary* instead of reciprocating, which means invariably much more quiet operation, less wear and tear of parts, and simpler mechanical applications. These are the advantages possessed by the electric motor that have led to its extended application on shore in place of steam. They are the same advantages which will be obtained by its use on board-ship. Two questions which are commonly raised about motors on shore by persons unacquainted with them will doubtless be raised by some officers in the service. They are, first: Can motors be made of sufficient size to do the work required of them? and second, Can they be relied upon to do the work as well and with as few break-downs as the steam-engine? The first question can readily be answered by simply stating that the regular *standard sizes* of the motors made by the Sprague Company range from one-sixteenth of 1 H.P. to 80 H.P., the list comprising forty or fifty types of machinery. In every case the rated H.P. is that *delivered from the pulley* of the motor. On all motors above 5 H.P. in size, the commercial efficiency (that is, the ratio $\frac{\text{H.P. given out by motor)}}{\text{H.P. absorbed by motor)}}$ ranges from 80 to 90 per cent.

The second question is best answered by a reference to the commercial world, where hundreds of these motors, of all sizes and types, are running 8, 10, and 12 hours a day, every day in the year, and on which the repair account in many instances does not amount to $10 for the year. It is in this direction that the greatest advance has been made in motors during the past three or four years. When they were first introduced, troubles with the field coils, "crossed" or "burned out" armatures, and commutators all cut to pieces by sparking and improper construction, were not of unfrequent occurrence. To-day such a mishap is extremely rare. Formerly, a motor was generally considered as a delicate piece of mechanism which must be kept under a glass case and labeled "handle with care." To-day we put a pair of motors under a street car, and run the car through snow, slush, mud, or rain, the car doing continuous duty for 16 or 18 hours out of the 24, and averaging from 90 to 120 miles per day. These facts speak for themselves. No service aboard-ship can approach that required of a motor for street car service, either in variation of speed or load, length of continuous duty, suddenness of shocks, strains and jars, unfavorable conditions of weather, streets, inaccessibility and narrowness of the space allowed, and lack of even a small amount

of attention. If we have a motor which is to-day successfully meeting and overcoming such conditions, is it unreasonable to predict that the same motor on board-ship, where every condition is vastly in its favor, will do as well and better? The street-car motors are put under a car within 6 in. of the ground, and the car is operated by an ignorant man who cannot even see his motors, who cares nothing about them, and who cannot tell one end of it from the other. These motors run, not by reason of any fostering care on the part of the motor man, but in spite of him.

Salt water has always been regarded as a hated enemy of the electric motor or dynamo, until within the past few months; its omnipresence aboard-ship would have been a serious objection to its use in many places. The same objection, however, had to be met and overcome in the street-car motor, and to-day we can actually soak an armature in a barrel of salt water, take it out, put it in a motor and run it. This is no idle boast, but a feat which has been actually accomplished. For some months the Sprague Company have been engaged in experimenting on a method of treating field coils and armatures with an insulating compound in such a manner as to render them impervious to water or acids. Recently an armature which had been put through the process was soaked for 24 hours in hydrant water. It was then taken out, measured, found to be sound in every respect, and then put into a barrel of salt water for 24 hours. At the expiration of this time it was taken out, put at once into a motor without a drying of any kind, and the motor was run for two hours on an overload varying from 25 to 50 per cent. above normal full load. No test could be more thorough or convincing, none more satisfactory to us. In future, all of our motors subjected to the influences of the weather or to any unusually unfavorable conditions will be subjected to this process.

The class of work to be done by motors aboard-ship may be divided generally as follows:

First Class.—Where the load varies, but speed of motor is constant—running lathes or drill presses, for example. For this work a differently wound, constant speed motor is most suitable. Such machines do not vary more than 2 per cent. in their speed from no load to full load. In some cases, where constancy of speed is not required within 5 or 10 per cent., a simple shunt machine will suffice.

Second Class.—Where it is desired to vary the load and speed only through a limited range—running ventilating fans, hoisting, and some pumping, for example. Here a cumulatively wound motor is desirable. In this case the field coil, in series with the armature, acts *with* the shunt coil in its magnetizing effect instead of against it, and a variation of from 15 to 30 per cent. in the speed can be obtained.

Third Class.—Where the load and speed vary widely, but where the motor is never without *some* load, as, for example, in steering, gun-training, and certain pumping. Here a plain series motor is the most suitable. The torque or turning moment of a motor varies directly as the product of the ampere turns in the fields and in the armature; in a series motor the same current passes through fields and armature; hence the torque varies as the *square* of the *current.* This means that in starting under a heavy load, or in moving the load slowly, a series-wound motor is capable of exerting an enormous torque for a short length of time.

These four types of motors will cover every class of work that an auxiliary engine on board-ship can be called upon to perform, and the motor will do it better in every instance than the steam-engine. The electric motor, as compared with the steam motor, is much more compact and lighter; simpler in construction, application, and operating; less noisy, cleaner, requires no skilled labor to operate it; is more reliable, more efficient, and *less* likely to get out of order. Every one of these points are points in its favor for ship use. Suppose the *Atlanta* had an electric motor instead of the steam-steering engine she has (which, by the way, takes up a whole compartment and makes the after part of the ward-room uncomfortably warm and noisy when in use). The motor would occupy about *one-fourth* the space, the steam and exhaust pipes would be replaced by the mains below the armored deck, and instead of the long line of shafting running from pilot-house to engine, a small controlling wire would run down from the conning tower through a small armored tube, and thence aft under the armored deck to the controlling switch of the motor. What a saving in first cost of installation, simplicity and ease of operation, and safety in time of action! Suppose the 8-in. gun-training engine, occupying a room by itself on the orlop-deck, was replaced by such a motor as the *Chicago* will have. The motor will be placed between the side brackets of the lower carriage and under the breech of the gun. It will be so geared that by throwing a single clutch either the motor or the hand-gear can be used. The long shafting running up through two decks is done away with, and the gun captain, with a simple lever in his hand, can train his gun with the greatest ease. I take pleasure in stating that the Sprague Company is now fitting such a motor (the first of its kind) to one of the 8-in. carriages of the *Chicago.* A smaller motor for elevating purposes is also being attached to the same carriage. At the same time, we have also put on board the *Atlanta* an ammunition-hoist motor to be used in whipping up the 6-in. and 8-in. shell, and having attached to it a very ingenious hand control. The same hoist can be used for hoisting ashes or for any general hoisting. A power-hoist is only advantageously substituted for hand-hoisting where weights lifted are comparatively heavy (100 lbs. or more), and where it is desired to handle them quickly with a lift of say 25 ft. or more. The principle of the floating lever as applied to steam ash-hoists is well understood. Briefly, the man handling the hoist must keep a small crank or wheel in motion in order to keep the engine moving. If he stops turning the wheel, the engine stops. If he reverses the wheel, the engine reverses. This control of the hoist becomes very important in hoisting loaded shell, powder, or high explosives. If a man is shot while hoisting, or if he becomes demoralized and lets go his hand-wheel or ceases to turn it, the engine must stop at once; otherwise, the shell might be detached from the whip and dropped down to the shell-room.

The new hand control carries out this principle fully. A man must turn a wheel in a certain direction to start the motor, and the speed increases as he increases the speed of rotation of his wheel. If he lets go the wheel, the motor is stopped. If he reverses it, the motor reverses. In testing the apparatus, it was at first found that when the current was cut off from the motor, the momentum of the armature carried it around for several revolutions, so that the weight being lifted or lowered was not brought to rest promptly. To remedy this, a magnetic brake has been applied to the armature shaft; the magnet coils of the brake (of very low resistance) are in series with the armature, and so long as a current is passing through the motor, the magnets are energized and the brake-shoes are held away from the shaft. When the current is shut off, a heavy spiral spring at once draws the brake-shoes together, and the armature is stopped.

These first two applications of motors on board-ship, the *Chicago's* gun-carriage motors and the *Atlanta's* shell-hoist, will doubtless receive much criticism in the service. Every new piece of mechanism does, and it is right and proper that they should receive such criticism, since naval officers know best what are the requirements and conditions on board-ship. It is only fair, however, that a new device should receive a full and thorough trial, and that when a criticism is made, there is a corresponding desire to improve. We already see where certain parts about the shot-hoist can be improved upon in any future orders, tending to simplify it and decrease the space occupied. It is the universal experience with all mechanical appliances, that successive improvements in them always mean a reduction in number of parts and simplifying of motions.

The chief object aimed at in applying the training and elevating motors to the 8-in. gun-carriage is to increase the speed of moving the gun, and to enable the gun captain to follow the object aimed at nearly or quite as readily as is now done with the Hotchkiss single-shot gun. A single universal movement lever controls both motors. The gun captain trains right or left by moving lever to right or left; if he wishes to raise or lower the breech, he raises or lowers the lever. A combined motion of the lever will

produce a combined motion of training and elevating or depressing. It would seem that with such a simple and complete control of his gun, a gun captain will be able to follow his target with almost, if not quite, the ease that he does with a 6-pounder Hotchkiss, since the motion of the gun is coincident with the motion of the man's hand, both in direction and in speed.

The application of a motor for steering purposes deserves special mention. It has been suggested to have a motor to operate the *valve* of the steam steerer only. While this would do away with the clumsy mechanical devices now necessary to transmit motion from the hand-wheel to the engine, it is only a step in the right direction. The moving of the *tiller itself* should be accomplished by a motor. The system would then be a completed whole, and there would be a large saving in space, weight, noise, and heat. The same hand control, already mentioned in connection with the shell-hoist, would be most suitable for steering purposes. The motor moving the tiller follows the motion of the wheel in the hands of the helmsman, both in direction and speed. If he stops turning his wheel, the tiller stops in whatever position it may then occupy. This is analogous to the motion of the present steam-steering engine. A pointer on the standard supporting the wheel indicates at any time the position of the tiller. It will be of interest to naval officers to know that the methods above described for adapting the electric motor to the handling of guns, steering, and hoisting, are themselves the design of a naval officer, Lieutenant Bradley A. Fiske.

It will be seen from the foregoing remarks, that in introducing the motor on board-ship, the navy will simply be following the experience and practice of commercial life, and there can be no reasonable doubt that the same advantages which have followed the introduction of the motor on shore will follow with even greater force its introduction on shipboard.

ELECTRIC RANGE-FINDER.

One of the latest applications of electricity to nautical and military purposes is the range-finder, also invented by Lieutenant Fiske. It is impossible at present to obtain the details of the apparatus, but it is known to consist of an electrical device by means of which the exact position of two telescopes at the ends of a base line of known length is automatically given. As applied to the *Chicago* and the *Boston*, the Bureau of Ordnance has insisted that the range-finder shall give accurate indications of the distance of objects on any and all bearings, and that it shall not interfere in any way with the working of the ship or any part of its armament or equipment. It is expected that this invention will increase the ease and value of fleet evolutions, since every ship will have absolute knowledge of her distance from the others ; and that it will lessen the dangers of coasting, since a vessel can plot her exact position as often as desired, having the means at hand for ascertaining both her distance and her bearing from any landmark, buoy, or lightship within sight. As an example of the accuracy of the instrument, it may be stated that the average error of 20 observations, half by night and half by day, was less than 1 per cent., the ranges varying from 500 yards to 2,600 yards, the instrument being the first one constructed, and necessarily crude.

SIGNALING BY ELECTRICITY.

One of the most serious problems to confront the commander-in-chief of a modern fleet or squadron is the transmission of signals in time of action to the vessels under his command. The enormous powder charges used in all modern high-power guns create such a smoke after the first round is fired that signaling by flags, semaphores, etc., is out of the question. It has been suggested that it is a perfectly feasible plan to communicate between vessels by means of electricity, either by induction or by the direct action of an electric current. Two years ago, while attached to the *Atlanta*, I assisted Lieutenant Fiske in some interesting experiments of this nature. While the results obtained were not as successful in point of distance as we had expected, we did transmit signals from the *Atlanta*, then lying at the dock (New York Navy Yard), to the tug *Nina*, stationed in the Wallabout, there being no wire connection of any kind between the two vessels. The man receiving the signals had a pair of telephones at his ears, and the make and break of an ordinary telegraph key in circuit with the *Atlanta's* dynamo was distinctly heard. The results obtained would, at least, seem to warrant further experimenting in the same direction. A man receiving such messages by telephone could be stationed on the orlop or berth-deck by himself, where he could be quiet, and he could then transmit them by speaking-tube or telephone to the commanding officer.

Night signaling is now extensively done by electricity. The incandescent light offers a ready substitute for the torch or signal lantern in signaling between vessels that are within sight of one another. Devices for signaling by the incandescent lamp have already been devised and described. The search-lights, however, offer a much more comprehensive system of signaling. Their powerful beam of light, when thrown into the sky, can be seen 20 or 30 miles away, and by having a quick-moving shutter or screen to cut off the light, the regular Morse code can readily be used in transmitting signals. Vessels separated by high land have thus communicated with each other and with forces on shore.

ELECTRIC ANNUNCIATORS, BELLS, GUN-FIRING CIRCUITS, ETC.

Electric communicators, bells, etc., have now reached such perfection and are so familiar to all that they need no description. They are largely used on all of our new vessels. The firing of the heavy guns by electricity, however, is a matter that should receive careful attention. Some experiments have already been made on board our older vessels, and new designs have been prepared for the Bureau of Ordnance for our new vessels which embody many improvements over the old system. While it may be true that the guns will ordinarily be fired by the gun captains, the commanding officer may nevertheless want control of the battery at a critical moment, and *this* is the time when the firing circuit will come in. It would certainly seem that the comparatively small outlay necessary for its installation would be well compensated for at such a time. Moreover, the gun captain himself should be able to fire his gun by electricity. An astronomer, when using a transmit instrument, records the transit of the body observed on the chronograph by pressing an electric button. He uses electricity because he has got to *record* simultaneously with the transit of the body across the wires in the field of vision. Just so the gun captain should be able to press a key and fire his gun the *instant* his sights come on the object aimed at, and this can be accomplished by electricity better than by any other known method.

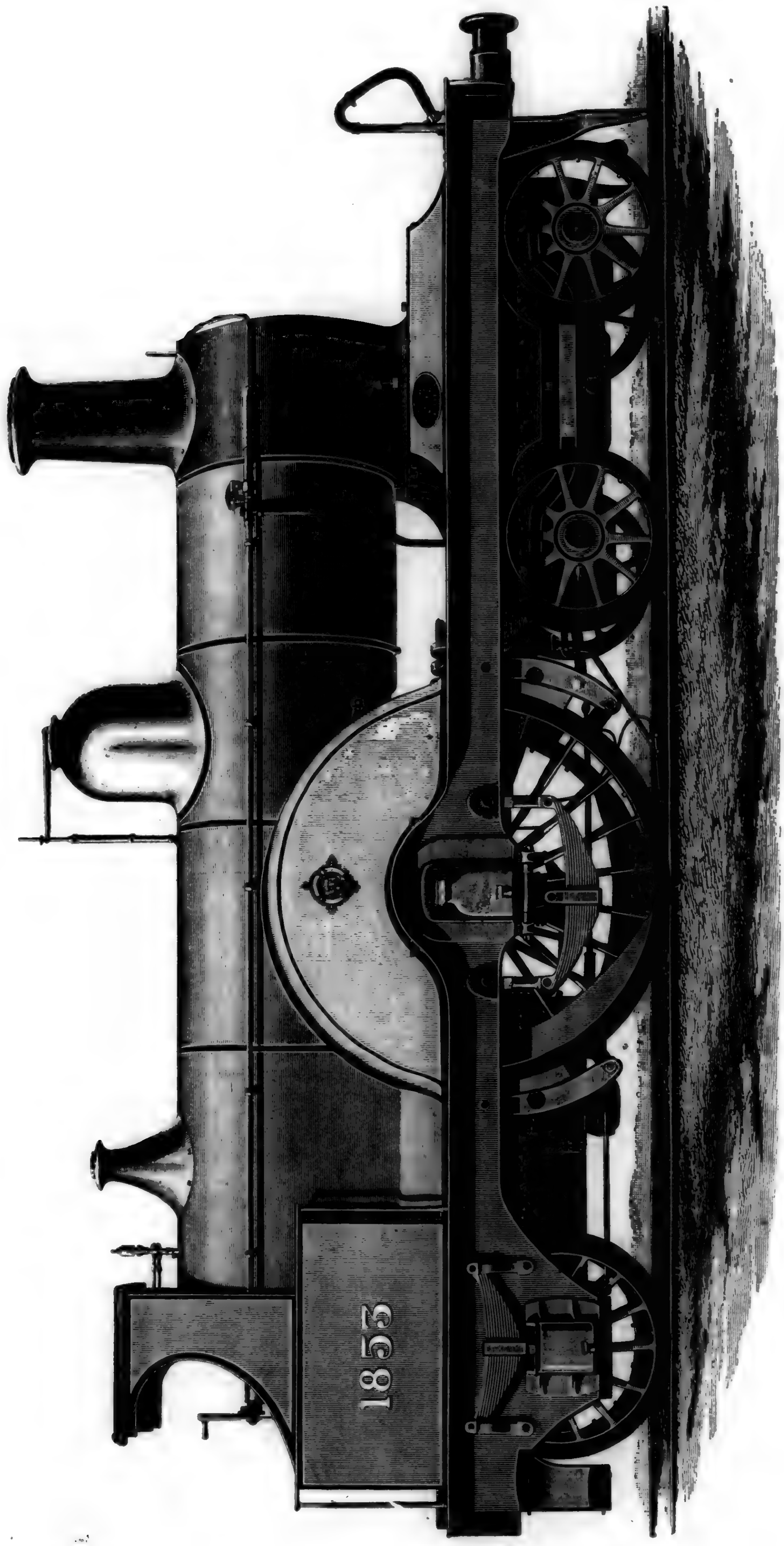
If electricity is to be introduced on board our war ships as generally as this paper contemplates, it is necessary that the Navy co-operate heartily with the manufacturers in their endeavor to produce what is wanted, and I feel confident that all officers who have the best interests of the service at heart stand ready and willing to do so. The use of electricity means increased efficiency and economy in the operation of all auxiliary engines on board-ship, and greater health and comfort for the officers and men.

ENGLISH EXPRESS LOCOMOTIVES AT PARIS.

(From the London *Engineer*.)

As many of our readers are aware, there are only three English locomotives of the first class exhibited at Paris. These are shown by the London, Brighton & South Coast Railway Company, the South-Eastern Company, and the Midland Company, whose engine forms the subject of our present illustration. The Midland system is one of the heaviest in the kingdom, traversing, as much of it does, a very difficult country. The speeds are high, and the trains weighty.

Hitherto all the powerful locomotives have been coupled. The engine exhibited at Paris is, however, a new departure, being a single engine—it is, we may add, the only single engine in the Exhibition—its use being rendered possible by the adoption of Gresham & Craven's sand-blast system, by which a fine spray of sand is blown under the treads of the driving-wheels by jets of steam.



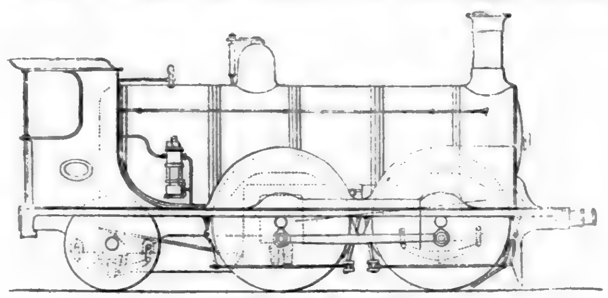
EXPRESS PASSENGER LOCOMCTIVE MIDLAND RAILWAY, ENGLAND.

SAMUEL W. JOHNSON, ENGINEER, DERBY, ENGLAND.

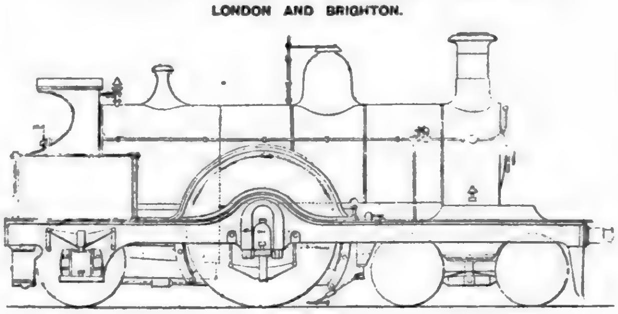
The following tabular statement gives particulars and dimensions of the engine and tender :

	Ft. In.
Diameter of cylinders	1 6½
Stroke	2 2
Lap of valve	0 1
Lead of valve in full gear	0 0⅛ full.
Distance of cylinders apart	2 4
Diameter of driving-wheels	7 6
" bogie "	3 6
" trailing "	4 4
Bogie center to driving center	10 0½
Driving center to trailing center	8 9
Bogie wheel centers	6 0
Wheel base, engine and tender	43 2¼
Working pressure	160 lbs.
Length of boiler barrel	10 ft. 4 in.
Mean diameter outside barrel	4 ft. 2 in.
Fire-box, outside length	6 ft. 6 in.
Number of tubes	244
Diameter of tubes	242 1⅝ in. diam. 2 1⅛ in. "
Heating surface, tubes	1,123 5 sq. ft.
" " fire-box	117 "
Total heating surface	1,240.5 sq. ft.
Grate area	19 6 "
Engine weight, working order	43 tons.
Weight on driving-wheels	17 tons 10 cwt.
Tender, water capacity	3,250 galls.
" coal "	3½ tons.
" weight, working order	30 tons.
Average gross load, London to Nottingham	170 to 215 tons.
Equivalent vehicles	9 to 13 carriages.
Booked speed per hour	53⅜ miles.
Coal consumed per mile	20 to 23 lbs.
Longest run without stop	124 miles.

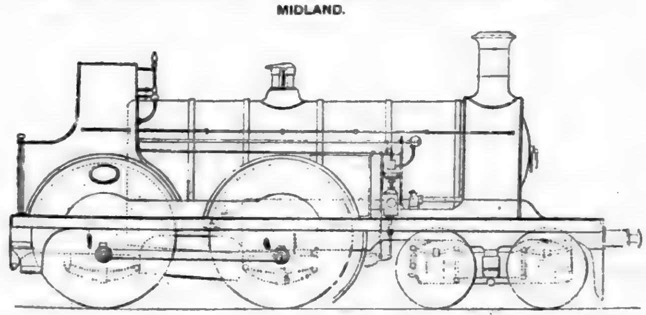
A glance at our engraving is quite sufficient to show that Mr. Johnson has designed an exceedingly handsome



LONDON AND BRIGHTON.



MIDLAND.



SOUTH-EASTERN.

engine ; and the finish and workmanship generally are of the highest class. The engine is painted the beautiful dark red which Mr. Johnson has introduced with so much benefit to the pockets of the shareholders ; and the large brass driving axle-boxes have an admirable effect.

The engine was designed in 1887, and there are now at work or in course of construction 15 of the class. In 1863 the prevailing type on the Midland Railway was a six-wheeled single engine. In the engine exhibited the boiler is of steel ; the barrel is composed of three rings put together telescopic fashion. The side frames approach each other in front to give room for the bogie. This is of the normal Midland type, with inside frames and balance beams. It has a horizontal traverse of about 1½ in., controlled by lateral spiral springs. The spectacle plate is of cast steel. The valve-gear is of the ordinary Stephenson's link type. Our contemporary, *Le Genie Civil*, publishes three outline engravings which we reproduce here, as they show very clearly the principal features of the three English locomotives.

CABLE TOWING ON CANALS.

(M. le Chatelier in the *Revue Scientifique*.)

THE International Congress on Water-ways, which met in Paris in July, and which was attended by many French and foreign engineers, paid particular attention to the question of Cable Towing.

French readers know that M. Levy and M. Oriolle have recently attempted definite solutions of this important problem, which each has worked out after his own method. It is to be hoped that public attention will be directed to these attempts, which are full of promise, and for that reason we have undertaken to explain both, and to see how far the plans which were discussed in the Congress answer the needs of inland navigation.

M. Derome, Chief Engineer of the Department of Roads and Bridges at Compiegne, has presented to the Congress a valuable report on the actual methods of towing boats on canals. At least four-fifths of the tonnage of the French system of internal navigation is towed by animal power, the horses or mules being furnished by the farmers who live near the canal, or by contractors who have an organized service for that purpose. On either plan this method of towing presents inconveniences inherent to the use of living motors. The animal consumes as much when at rest as when at work, and its use will only pay when its daily work is practically equal to the proportion of the average yearly work which can be exacted from it. It is also true that the effective work of the horses used for towing cannot exceed a certain amount, and that the force is insufficient to meet the demand as soon as the movement of traffic passes the average limit. The result is that the boats on the canal must wait their turn for towing ; the length of the trip becomes uncertain ; the requirements of commerce are not properly met ; and there is a tendency to raise the rates of freight. Moreover, the movement of boats is irregular ; the locks are sometimes idle, because there are no boats ready to pass through, and again they are overcrowded and cannot pass the boats fast enough ; from this there results an expensive delay of traffic.

To secure a regular movement of boats on our waterways, is to increase the tonnage which they can carry ; to diminish delay, and to enable the boats to increase the number of trips which they can make in a year. This is the object at which engineers have aimed in endeavoring to replace animal towing by some method of mechanical towing.

The problem is a serious one ; and the object is really to place the canals on the level with other industrial enterprises ; to do for them what the locomotive has done for the railroad.

M. Derome has described the different plans thus far tried for mechanical towing, by locomotives and other methods. Very much depends on the cost of the work, since the present plan is very cheap, the cost being somewhat less than 0.1 cent per ton per mile on the average. Cable towing promises a still further reduction, and for this reason it deserves serious attention.

This term "Cable Towing," adopted by the Congress, defines the system very nearly. A fixed motor drives an endless cable supported at proper distances by pulleys ; this cable runs along either bank of the canal in opposite directions. Each boat is attached to this cable on one side or the other, according to the direction in which it is go-

ing, and can be cut loose at will. The abstract idea is extremely simple, but the conditions arising in practice bring in many difficult complications.

Suppose a boat on the canal at rest and weighing, say 400 tons with its load. The cable which should draw it is part of a circuit some 10 miles in length; it weighs 100 tons and moves at a speed of 200 ft. per minute. Such heavy weights cannot possibly communicate their respective speeds to each other at once without developing an enormous resistance for a short time; but the connection between the boat and the cable is made by a rope which must be comparatively light and weak. From this arises the first difficulty: *The boat must be put in motion gradually.*

When the boat has acquired the same speed as the cable, it must be kept away from the bank and near the center of the canal, where the greatest depth of water will be found under its keel. It is, therefore, running at a certain distance, say from 35 to 40 ft., from the cable; the tow-rope must be two or three times that length, and will therefore act on the cable in an oblique direction, and will tend to pull it off the carrying pulleys. It will be seen that the form of these pulleys may oppose this tendency, but when the point where the tow-rope is secured to the cable passes over a pulley, special precautions must be taken to prevent this tow-rope when it leaves the pulley from drawing the cable after it. Hence arises the second necessity: *The cable must be under no danger of leaving the pulleys.*

Another point to be considered is the constant variation in the power needed to move the boat. It has been found almost impossible to work out any definite formula, but if we assume that the average power needed to move a boat of 400 tons at a rate of 200 ft. per minute, is about 880 lbs., it will be found that in practice it may vary from 0 to 2,200 lbs. The wind, the passing of a boat moving in the opposite direction, the passing through a narrow section of the canal, etc., are sufficient causes of this variation; but there is another, less perceptible and consequently more dangerous. In passing a boat from one level on the canal to another, it is necessary to draw from the upper level into the lower a certain volume of water, and this for a time lowers the water in the upper level, and raises that in the lower level by several inches. The opening and closing of the lock occupies only a very short time, but a much longer time is required to produce the effect on the two levels of the canal. From this there results an action which has never been accurately observed or formulated, and which is, on a small scale, very similar to that of the tidal waves found at the mouths of certain rivers. It is caused by the difference between the rapid rising of the tide in the open sea and its comparatively slow action in the narrow channel of the river. On the levels of the canal no current is visible to the eye, but there is a slight wave which is well known to the boatmen, and which on very short levels may pass back and forth several times from one end to the other. If this wave strikes a moving boat, either in front or from the rear, the resistance of the boat is either increased or diminished by a sensible fraction of its total amount.

From all these causes—and, perhaps, from some others—a boat moving through the canal at a constant speed exercises on the tow-rope a force which is incessantly varying in degree, and if we observe this rope from the boat we will see, perhaps with some surprise, a constant change in its tension. With a mechanical motor, account must be taken of these changes, to which an animal motor—a horse, for instance—soon learns by instinct to accommodate itself.

This is not all. Wherever there is a water channel there are obstructions and irregularities in the bottom, and if they do not exist in the first place, the carelessness or the lack of common sense—if such a term may be used without insulting them—of the boatmen would soon make them. When a boat strikes such an obstruction, the horse which draws it will fall back and perhaps tumble into the water; but to that the animal is accustomed and will speedily recover itself. An engine or any other mechanical device would not know how to save itself, and some protection from accident must be provided. Hence arises the third principle: *The variations in resistance to traction must not affect too much the towing system.*

We now have the general conditions of the problem; but in applying these there will be found many others which will be constantly varied by the local circumstances of the case. The banks of a canal, with the interruptions made by bridges and by the walls of the locks, show both in plan and elevation a constantly changing form, which the cable must follow, and instead of forming two straight parallel lines, it will present a number of angles which may be in a geometrical plane anywhere between the horizontal and the vertical. Under all these conditions the cable must remain *strictly underailable.*

The solutions of this problem worked out by M. Levy and by M. Oriolle are radically different. It is true, however, that the local conditions under which each one worked were also very different.

The place where M. Levy made his experiments, and where he claimed—perhaps somewhat too soon—the honor of solving the problem, is the Junction Canal between the Seine and the Maine. In consequence of its position, this canal is only used by the boats running upon those rivers, which are well equipped, and carry more than one man on board. These men are accustomed to careful management of the boats, and especially to the operation of attaching a boat to a large tow while in motion.

The St. Quentin Canal, where M. Oriolle made his experiments, is part of the main line of navigation between Paris and Belgium. The boatmen on this canal are a peculiar class, each man generally owning a single boat upon which he lives with his family. He is accustomed to the common navigation of the canal, not always very skilled in his business, and so much afraid of river navigation that when he leaves the canal for the river, he often puts his boat in charge of a pilot, who, perhaps, knows no more about it than himself. It may be added that the Junction Canal has a large section; its locks are considerably over the normal size, and the traffic upon it is not sufficiently great to cause blocks or obstructions, except in very extraordinary cases. On the other hand, the St. Quentin Canal is one of the most frequented water-ways in the country, and to be overcrowded is its normal condition, making its navigation always difficult, while still further trouble is caused by the shortness of the levels, the small dimensions of the channel, the great number of bridges and locks, and the intricate arrangement of the approaches to many of the locks.

The system of M. Levy * requires the work of the boatman under all circumstances of speed and variation of resistance. According to it, the boat cannot be handled by a single man, and the boatman must be ready at all times and must also be quick in action. The tow-rope is fastened to the cable in a very ingenious and simple way. At short distances apart clutches are mounted on the cable and invariably in position, and these clutches carry each a ring, to which the tow-rope is fastened by a sort of slip-knot, which can be loosened by drawing upon a small cord extending to the boat. I may here call attention to the necessity of leaving the cable free to rotate upon itself; this motion is one of the consequences of its mechanical action, and it is one of the points which have been neglected by inventors.

What forms the chief point of M. Levy's invention is the arrangement for preventing the cable from leaving the pulleys. The cable is very heavy and, independent of all external forces, its weight exercises a permanent tensile strain which is important. The other forces acting upon it, the oblique and irregular traction of the tow-rope are entirely neglected by him. The pulleys are very simple in form, and the cable cannot possibly leave them; in fact, they present no particular feature, except that there is a series of slots on the side toward the canal, which are intended to cause the tow-rope to leave the pulley at the proper point, and which do sometimes assist it. These pulleys form the summit of a triangle, of which the base is the course of the boat, and are almost always passed over freely by the tow-rope when it is held taut, and consequently apt to draw off without difficulty. They are mounted in a plane inclined from the horizontal toward the canal, and the slots have a wide opening. In this way

* M. Levy's system was described and illustrated in the JOURNAL for April, 1889, page 167.

one difficulty has been overcome in a very ingenious way, but not without changing somewhat the line of the cable.

Many members of the Congress visited this canal and observed its work, and they have made some observations, among which are the following:

It seemed to them, in the first place, that the necessity of attaching the tow-rope at certain fixed points on the cable, and of detaching it completely when it is desired to stop the boat, makes it necessary to keep the cable very low—that is, at such a point that it can always be reached by the boatman's hand, and that this position gives room for accidents to persons. It also seemed to them that the importance attached to the work of the boatman and the necessity for him to step from the boat to the tow-path whenever the tow-rope was to be loosed or attached required considerable extra work, and made it imperatively necessary that there should be two men on the boat, one to steer and the other to watch the attachment. This probably would not be any objection on the canal in question, where the boats coming from the river and returning to it are well manned; but it might be of importance on other canals. Some doubt was expressed as to the durability of the cable, owing to the high degree of tension to which it is submitted, but the care with which the details of the work have been carried out received much praise.

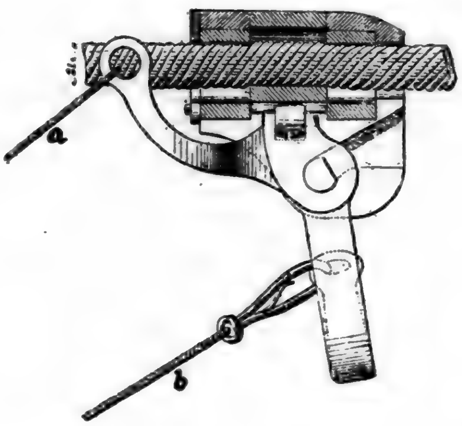


Fig. 1.

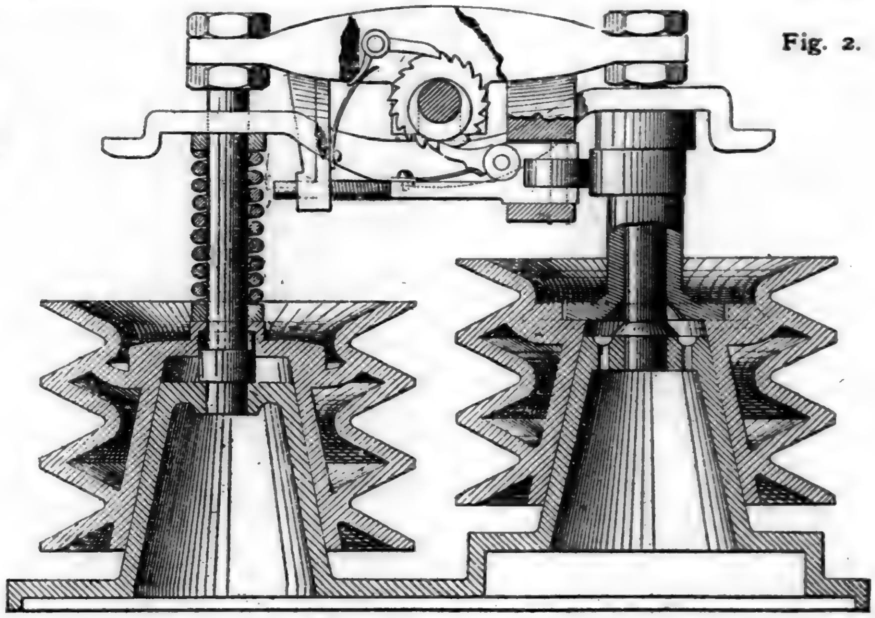


Fig. 2.

It seems that M. Oriolle desired in all points to make a strong contrast between his arrangement and those of M. Levy. His cable is as light and subjected to as little tension as possible, and here there is a considerable advantage in the first cost. The point which allowed him to diminish the permanent tension is the very excellent idea of suspending his pulleys from above by a sort of swinging hanger or frame, instead of a fixed support—thus allowing them to follow somewhat the movement of the cable. Instead of commanding the motion of the cable, the pulleys follow it, and the tendency to derailment is thus largely reduced, and what remains is done away with by a guide attached to each pulley, which forces the tow-rope and the clutch which holds it to the cable to run over the pulley in the most favorable position.

Aside from these details of construction, the originality of the idea is in the method of attaching the tow-rope to the cable and to the pulley. After many experiments M. Oriolle has reached the form shown in the accompanying illustrations, figs. 1 and 2, which are necessary to make the description clear. Fig. 1 shows the clutch which fixes the tow-rope to the cable and by which it can be thrown loose altogether. When the boat is to be attached, an attendant puts a clutch upon the cable, and fixes the tow-rope *b* to one of the levers; to the other he attaches a cord, *a*. It will be seen from the drawing that the boatman can: 1. By holding the ends of the tow-rope *b* make the clutch grip the cable and draw the tow along, the rotary movement of the cable remaining possible. 2. By drawing on the cord *a* break the connection and hold the clutch in place, the cable passing through it without drawing it along. The clutch is composed of an iron box or case in which are three rings. The lever with two arms is carried upon a lug attached to the clutch; the tow-rope and the cord are fixed, one to each arm of the lever. The working of this clutch is very simple. The tension of the tow-rope causes a roller to bear upon the middle ring and holds the cable between the two outer rings with a force proportioned to the tension. If the cord is drawn, acting upon the other arm of the lever, the rings are loosened and the cable slips through them without moving the clutch.

With this arrangement there is no necessity of reaching the clutch by hand, and a boat once attached to it can be started and stopped at will, without the boatman having to step on the tow-path, and without his having to wait for the passage of another clutch to start the boat again. This condition is indispensable on the St. Quentin Canal, where navigation, in consequence of the many delays and the number of locks, is a constant succession of stops and starts.

The tow-rope attachment is a very important invention, and enables the boatman to handle the rope without difficulty and very quickly. This arrangement is shown in fig. 2, and consists of two cast-iron grooved pulleys, each carried upon a conical pivot, also of cast iron, and made in one piece with the bed-plate by it which is fastened to the deck. The tow-rope is rolled around these pulleys, and when the boat is fastened to the cable, it moves around them, causing them to turn with it. In this movement the pulleys are forced down upon the pivots, the pressure gradually increasing at each turn. After nine revolutions, the pressure is so great that the pulleys cease to turn under the ordinary strain of traction; and this strain, which at the start is nothing, thus gradually attains the maximum necessary for towing the boat at full speed. In this way a sudden strain on the cable is avoided, and one of the objects which we have already noted is secured. As a further security, the cord which loosens the clutch is fixed to a lever forming part of this towing-post. If for any reason the strain is suddenly increased and passes the calculated maximum, the pulleys begin to turn again, and the cord, acting upon the lever, loosens the clutch, so that the pulleys are once more set free, and can turn, allowing the tow-rope to pass through them. In the case actually in trial, the maximum strain to which the pulleys are adjusted is fixed at about 990 lbs.

This arrangement was very much admired by the members of the Congress who have seen it, and by its use, it is believed that several of the objections urged to cable towing will be entirely obviated. Instead of being obliged to execute a difficult and sometimes dangerous operation, the work of the boatman becomes entirely easy and simple, while when the boat meets with obstruction, the action is

quick and automatic, and does not depend upon the skill or promptness of the attendant.

There is no hesitation in saying, then, that the Oriolle system fulfills the conditions of the problem, while the Levy system is wanting in certain points, although it is, perhaps, well adapted to the particular circumstances under which it has been tried. In other words, one of these systems can be applied only under peculiar conditions, while the other has a very much larger future before it.

These improvements must be regarded with great satisfaction, because it has long been evident to engineers that some form of mechanical traction is necessary to enable us to realize the full advantages of the canal system.

A NEW CHILIAN BATTLE-SHIP.

SOME two years ago the Chilian Government appointed a board of naval officers to contract for several new vessels for its Navy. Sir Edward Reed, the well-known English naval architect, was chosen as Consulting Engineer for this board.

Under this action contracts have already been let in France for two cruisers of 2,000 tons displacement, and in England for two torpedo-chasers of 730 tons displacement. More recently bids were asked for an armored battle-ship, the bidders to furnish plans also, only the general plan being given by the board.

The conditions were that the ship should be 6,000 tons displacement, or somewhat over; should have belt-armor of Creusot steel; should carry an armament of four 24-cm. (9.45-in.) and six 15-cm. (5.91-in.) guns; should be capable of making 17 knots an hour with natural draft and 19 knots with forced draft, and should have a cruising limit, at 10 knots an hour, of not less than 7,000 knots, with a normal coal supply.

Twelve bids were received, seven from English, three from French, and two from German firms. The bids ranged from $1,900,000 to $2,300,000, and the contract has been let to the French Société des Forges et Chantiers de la Mediterranée, the price to be $1,904,000.

This firm was the only one whose plans provided for a central armored casemate extending above the armored belt to the upper deck, and protecting the machinery and boilers, an arrangement which has been very generally adopted for vessels of a similar class in the French Navy.

Its plans also provided for the substitution of eight 12-cm. (4.72-in.) rapid-fire guns for the six 15-cm. guns, thereby somewhat increasing the weight of the battery, and very much increasing its fighting efficiency.

Fig. 1.

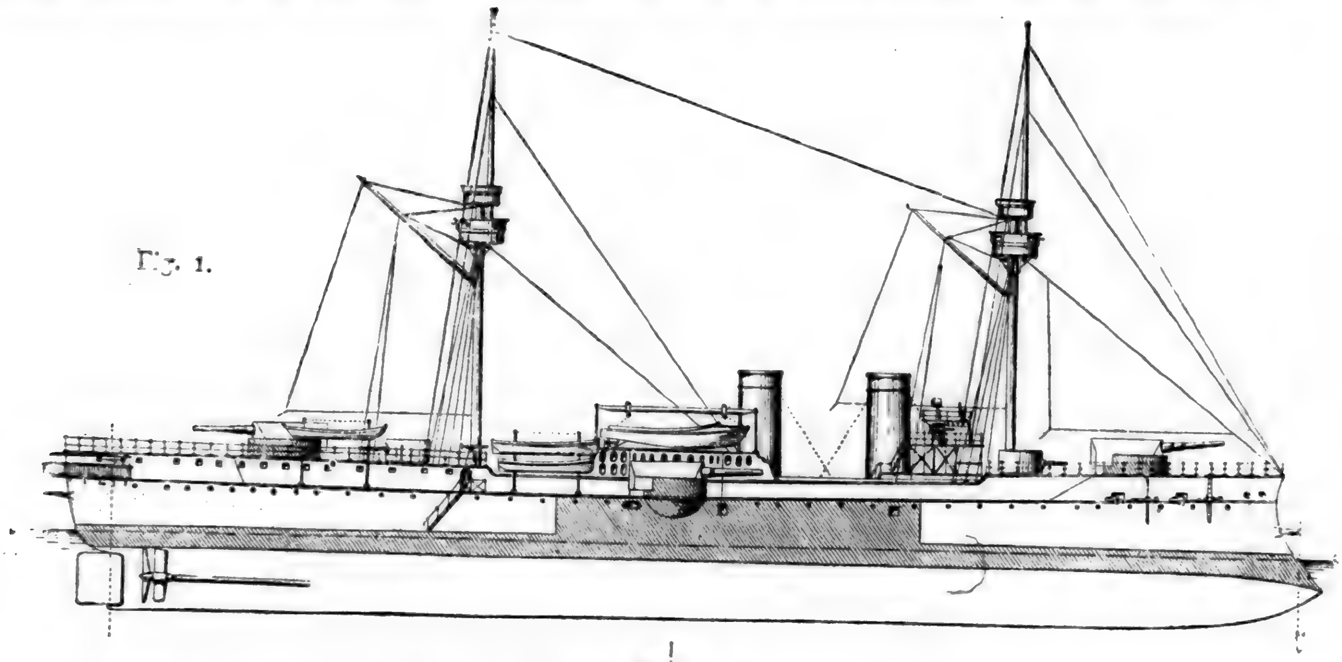
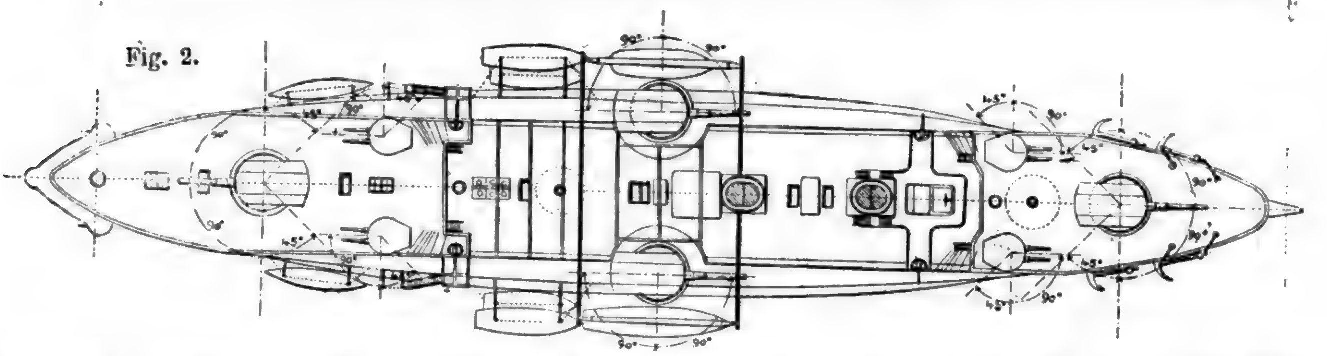


Fig. 2.



A further detail of this plan was the arrangement of cells or compartments between the lower deck and the armored deck, to increase the buoyancy of the ship.

The armored belt is 2.10 m. (6.89 ft.) wide and its maximum thickness is 300 mm. (11.81 in.). The central casemate or citadel is 41 m. (134.5 ft.) long and 18.50 m. (60.68 ft.) in width.

The general dimensions of the ship are as follows:

Length between perpendiculars	100.00 meters	(328.00 ft.).
Breadth over armor	18.50 "	(60.68 ")
Depth from upper deck	10.64 "	(34 90 ")
Average draft	6.65 "	(21.81 ")
Immersed cross-section	109 50 sq. m.	(1,179 sq. ft.).
Displacement at average draft		6,901 tons.

Distribution of weight:

Hull	2,240 tons.
Armor, including deck-plating	2,108 "
Boilers and machinery	1,145 "
Guns and ammunition	665 "
Ordinary equipment	160 "
Crew and stores	183 "
Normal coal supply	400 "
Total	6,901 "

These plans differed somewhat from the dimensions of the plan prepared by the Consulting Engineer, but the modifications proved acceptable to the board, and the bid was, as stated above, accepted in preference to any of the

others, although it was not the lowest. The central casemate was considered better, in principle and detail, than the two turrets which were provided for in some of the plans.

In the accompanying illustrations, for which we are indebted to the *Mittheilungen aus dem Gebiete des Seewesens*, fig. 1 is an elevation and fig. 2 a deck plan of the ship, showing the general arrangement of the armor and guns.

From the drawings and description, it appears that our South American neighbor will, when this vessel is finished, add to its Navy a battle-ship formidable for its speed and for its offensive and defensive powers.

THE DEVELOPMENT OF ARMOR.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

I.—EARLY EXPERIMENTS.

ALTHOUGH the modern battle between the gun and the armor-plate began at Kinburn, in 1855, it must not be supposed that the idea of using metal, or other protection against an enemy's missiles, had not been considered long before. In fact, as early as when men first took to the sea and began to settle their disputes in naval encounters, we find record of a resort to artificial protection for ships' bulwarks and the men who were to fight behind them. When the Mediterranean buccaneer fastened leather or raw-hides along the side of his galley, it was the first resort to armor of which we have knowledge, and the marauding Normans in hanging their bucklers along the sides of their ships accomplished the same object. Later, in the twelfth century, these same enterprising Normans are said to have built war vessels with a belt of iron above the water-line. In the sixteenth century, when the Knights of St. John furnished a war-ship to Admiral Doria for his expedition against the Tunisian pirates, we read that it was plated with lead to keep out the barbarian shot.

It was, however, in the famous three years' siege of Gibraltar, made memorable by the heroic defence of Governor Elliot and his English garrison against the combined forces and fleets of France and Spain, that we find the first appearance of anything that would resemble a modern ironclad. Under the direction of the French engineer, d'Arçon, ten floating batteries had been constructed, the roofs of which were bomb-proof and the sides protected with 6 ft. of hard wood, reinforced by cork, hides, and bars of iron, and supplied with more than 200 of the heaviest guns. One can imagine that when on one September day in 1782, these marine monstrosities appeared before the eyes of the starving garrison, backed by the combined French and Spanish fleets, and opened their murderous cannonade, the English cannoneers went to their guns with but faint hope of victory. For hours their shot rattled harmlessly against the decks and sides of these uncouth adversaries, and not until by a happy inspiration hot shot were resorted to did it seem possible long to endure the terrible rain of missiles poured into the British batteries. But wood and iron could not withstand red-hot cannon-balls, and one by one the dreaded ironclads caught fire, drifted out of the fight, and at last blew up, until nine out of the ten had succumbed to flames and powder, and save a few hundred survivors picked up by English boats, their entire crews perished.

This was a brave beginning, but an unfortunate one for the ironclad, and for more than half a century no pronounced effort was made to repeat the experiment.

In discussing the question of armor, it is understood that the term, as usually employed, refers to any metallic protection superimposed upon the original structure, whether that structure be the side of a ship or the walls of a fort. In a more general way it is used to designate any artificial protection, even when not of metal, and also, as in the case of land defenses, when the whole structure is of metal.

The havoc wrought at close quarters on shipboard by the inferior ordnance of the seventeenth and eighteenth centuries, and the experience gained on land in countless sieges during the same period, must have made apparent the advantage of something in the way of extra protection to ship and fortress. On land the difficulty was met by an increase in the thickness of wall and in the quality of the material employed, but on the sea, so long as the solid shot was the only projectile employed, the sailor was content to take his chances behind his wall of oak. When, however, about the end of the first quarter of the present century General Paixhans discovered a way to fire hollow projectiles containing a bursting charge from ordinary guns, the necessity for this protection became obvious, and could no longer be neglected. It should be said here that up to this time the use of shell, or bombs, as they were called, was restricted to mortars, or short pieces, where the projectile could be placed in the gun by hand.

Against walls of good masonry the new missile was found to be inferior to solid shot, so the introduction of the shell-gun had little significance to the engineer, who went on building his forts upon the old lines, simply increasing the thickness of his granite walls to meet the increased power of the attack. His awakening was to come some years later with the advent of the rifle.* The man on shipboard, however, realized that a shell would prove far more destructive than round shot, and attention was naturally turned toward providing metallic protection for his wooden bulwarks. Before this could take practical shape it was necessary to ascertain the resisting power of the metals to artillery projectiles.

The first systematic attempt to ascertain this resistance was begun in 1827 at Woolwich, in England, by General Ford of the Royal Engineers. He constructed a target of two layers of square wrought iron bars, aggregating 2¼ in. in thickness, the outer layer horizontal, the inner one vertical. A backing of 7 ft. of Aberdeen granite was provided. This target he attacked with solid shot from 24-pounders at 600 yards' range. Twenty shots were sufficient to so displace and break it up that the experiments were for the time being abandoned.

The subject, however, still held a prominent place in the minds of thinking military men and others interested in military matters, and in 1841 Mr. Robert L. Stevens, of Hoboken, N. J., who, with his brother, was endeavoring to obtain assistance from the Government in the construction of an iron-protected floating battery, in a letter to a Government Committee on Coast and Harbor Defense, reported as the result of a series of experiments they had made, that a thickness of metal of from one-half to two-thirds the diameter of a shot, if inclined at an angle of 45°, was sufficient to resist penetration; and also, that wood had to be 16 times the thickness of iron to offer the same resistance. Mr. Stevens may be said to have inherited from his father the idea of a floating ironclad battery, and in the end sank a fortune in attempting to carry it out.

In 1846 experiments with armor were resumed in England, and may be said to have been continued almost without interruption to the present day. The first experiment was with a ⅝-in. rolled wrought iron plate and a 32-pounder smooth-bore gun. The plate proved wholly inadequate to the requirements, and an increase in thickness naturally followed. Without going into the details of the many experiments carried on during the 10 years immediately following, it will be sufficient to say that at the end of this period 4½ in. had been reached. The plate of this epoch was not solid, but made up of a number of thinner plates each about 1 in. in thickness and bolted together. It was found to resist fairly well the attack of guns up to the 68-pounder at moderate ranges. In all of these experiments cast iron projectiles and plates of rolled wrought iron were used.

In the United States, from 1853 to 1855, General Totten, of the Engineers, conducted a series of experiments to test the value of iron plates as a protection for the masonry walls of fortifications. Rifled cannon were at this time making their appearance, and the engineer had awakened

* The doom of masonry as a material for fortifications was sounded at the siege of Fort Pulaski in 1862, where rifled guns of very moderate power breached walls of masonry at the distance of a mile or more. This lesson was confirmed in the following year, where rifled ordnance did very effective work against the walls of Fort Sumter at a range of 4,000 yards and over.

to the fact that walls of brick and granite could no longer be implicitly relied upon to withstand the new weapons.

In these experiments targets were constructed of granite, brickwork, hydraulic cement, and concretes of various kinds. These were covered with wrought iron plates of from ½ in. to 8 in. in thickness, and fired at with different projectiles, from grape-shot up to the heaviest then in use. Two important facts were demonstrated by these experiments; one, that masonry was by no means a good backing for iron armor; that it was broken up and disintegrated by the blows of the projectile, even where the plate itself was comparatively uninjured. This fact was more completely emphasized in later experiments, when, after the introduction of rifled projectiles, the energy of impact was greatly increased; the other fact demonstrated was that a single solid plate of any given thickness offered much greater resistance than a laminated one. Brickwork and some of the concretes were found to resist disintegration much better than granite. Experiments in England of a little later date demonstrated the same facts, both as regards masonry backing and the superiority of solid over the built-up armor plate. The superiority of wrought iron projectiles over those of cast iron was also thoroughly demonstrated both in England and in Russia.

The Crimean war not only witnessed the advent of the first rifled cannon, but it also furnished for the advocates of armor-plating for ships a powerful argument. The destruction of the Turkish fleet at Sinope, in November, 1853, by the shell-fire of the Russian ships, demonstrated most completely the murderous effect of the new projectile, now for the first time tried in battle, and placed beyond the shadow of a doubt the necessity for armor protection for ships of war. The actual annihilation of 12 out of 13 war-ships and transports within the space of a few hours, with the loss of nearly 4,000 souls, was well calculated to carry conviction.

Up to 1857 the 4½-in. plate had been found to be a fairly equal match for the 68-pounder, but it was easily seen that something offering greater resistance would soon be demanded. The difficulty as well as the cost of producing wrought-iron plates of considerable thickness led to experiments with metal in other forms. In this year, at Woolwich, cast iron was experimented with in the shape of beams 2½ ft. in thickness, tongued and grooved and partially backed with blocks of granite; 68-pounders at 400 yards' range easily cracked and displaced the armor and broke up the granite backing. Later, in Russia, cast-iron blocks 4 ft. in thickness, proposed for forts, were experimented with with a gun of the same caliber firing solid cast-iron shot at short range. The target was destroyed at the fifth shot. In England, in 1859-60, wrought iron in other forms was experimented with in the Thorneycroft shield. This was built up of iron bars, tongued and grooved in horizontal layers, and of various thickness—from 6 in. up to 14 in., with and without backing. It was found to withstand shot up to that of the 120-pounder Armstrong rifle. In 1862 the Inglis target, consisting of two layers of wrought-iron planks crossing each other at right angles, and 12 in. in thickness, was fired at with guns of various calibers, and found capable of resisting perforation from the 300-pounder Armstrong rifle at 700 yards. At West Point, in the same year, the 100-pounder Parrott rifle was able to perforate 6 in. of laminated armor, made up of one inch plates and similar to that used on the Monitors.

Up to the end of 1862 English armor-plate had reached a thickness of from 5½ to 6½ in., and was able to resist the 68-pounder smooth-bore and the 120-pounder rifle, except the latter at the shortest ranges.

In this year a special Committee on Armor, composed of army and navy officers and civilian experts in metallurgy, made an exhaustive report, wherein it was stated that steel and steely-iron were not suitable materials for armor—were much inferior to soft iron. From this date, and for many years, England was committed to wrought-iron armor, and still clings to it in conjunction with steel in her compound armor-plate.

In the development of warlike material there has been quite as much ingenuity displayed, and, one might add, time and money wasted in attempts to perfect armor, as in any other direction. In the United States, the War of the Rebellion was a powerful incentive to the inventive genius of the country. Under the stress of war and urgent necessity all sorts of devices were experimented with by ordnance boards and artillery experts—devices that, seen in the light of present knowledge, seem so absurd that one wonders how they ever came to receive serious consideration.

Among the experiments recorded in 1862-64 in the United States, we have the Hodges wire target, in which, behind a thin laminated plate was placed 14 in. of wire rope in layers, with a backing of wood. An 11-in. gun at short range had no difficulty in riddling the target. An inclined target of laminated plate backed with India rubber and pine met with no better fate. A 4½ in. solid plate, faced with several inches of rubber and another of the same description, both faced and backed with the same material, was also tested. Another target was made up of alternate layers of rubber and wrought iron each an inch in thickness. Perhaps the most absurd experiment recorded was one made at the Washington Navy-Yard, where most of these experiments took place. A 50-pounder rifled gun was pitted against a compressed hog's-hair target about 3 ft. in thickness, with a backing of pine plank. Of the result it is unnecessary to speak.

In England some experiments of the same kind were made: Millboard of considerable thickness as a backing for a thin armor-plate; targets of compressed wool; of iron sandwiched with wood, and others both faced and backed with wood were tried at different times with no satisfactory results; in fact, it may be said that both in England and the United States scarcely one of the targets mentioned survived a single experiment.

With a date corresponding to about the close of the war, the question of armor-plate had passed beyond its purely experimental stage, and the best methods of construction were pretty well established. The solid plate had completely won the day over the laminated one, and the question of proper thickness was the principal one to be decided. Wrought iron held the field, and its claims to superiority over other metals were to be determined at a considerably later day.

As a corollary to the growth of armor-plate was the improvement in the manufacture of projectiles. Whitworth had not only demonstrated the superiority of a spherical steel shot over one of cast iron, but had sent his steel bolt through a target that had defied all other projectiles with an ease that surprised the artillery experts of the day. Still the age of steel, as a military material, had not yet arrived, and the best things the artillerist had to offer against the increasing thickness of the armor-plate were projectiles of chilled cast iron. When, however, soft armor gave place to hard, cast iron in every shape went to the scrap-heap and steel usurped the field.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE report submitted by the Board which conducted the official trials of the new cruiser *Charleston* on the Coast of California, makes a very favorable showing for that vessel. On the four hours' trial run, the average power developed by the engines was 6,666 H. P., the maximum being 6,943 H. P. The average speed during the whole run was 18.187 knots, and the maximum speed was 18.75 knots. The manœuvring power of the vessel was excellent, as she was rapidly managed and turned quickly. The main exception taken by the Board was to the difficulty experienced and time lost in communicating directions to the people stationed in the steering chamber, where the hydraulic apparatus is situated, and the Board say that some more reliable means of communication is desirable; also some device from changing from one steering apparatus to the other nearer the deck. The conclusions reached are that the vessel's hull, fittings and machinery, including the engines, boilers and appurtenances are strong and well built, and, with one or two slight exceptions, in conformance with the contract; the vessel is also in their opinion sufficiently strong to carry the equipment, coal, stores, machinery and the armament which has been

assigned to her. On this report there is no doubt that the *Charleston* will be accepted from the contractors.

Engineer-in-Chief Melville has been during the month in New York making arrangements for building the machinery of the two 3,000-ton cruisers in that yard. The hull of one of these vessels is to be built at the New York yard, and that of the other at the Norfolk Navy Yard, but the machinery for both will be built in the New York yard. Work has already been begun in both yards, laying down the lines for the hulls of these vessels, getting the keel-blocks in place, etc., etc., and the material has been advertised for. The preliminary work is to be hurried as much as possible, and probably the keels will be laid down by the end of the year.

The plans for the two 1,000-ton protected gun-boats authorized by the last naval appropriation bill are nearly completed, and advertisements for bids will shortly be issued. These vessels are known officially as cruisers Nos. 12 and 13, and will be somewhat larger than the *Petrel*, just completed in Baltimore. They will carry batteries of 6-in. rapid-fire guns, and smaller machine guns, will have twin screws with triple-expansion engines capable of working up to about 1,600 H. P. The speed expected is 15 knots per hour. It is believed that these ships will be exceedingly useful to the Navy, and on many stations will answer all the purposes which could be served by a larger and more expensive cruiser. The need of ships of this class has been very much felt. Their cost is limited to $350,000 each.

It is understood that the Commission appointed some months ago to select a site for the purposed navy yard on the South Atlantic or Gulf Coast has not yet reached an agreement, but it is stated that the majority of the Board favor one on the Mississippi River nearly opposite New Orleans. This site is preferred as being on deep water, with facilities for transportation of material and for obtaining skilled labor; but, at the same time, is in a position easily defended in case of war. The navy yard at present owned by the Government at Pensacola is not considered available on account of the unhealthfulness of the situation, its liability to epidemics of yellow fever, and the impossibility of obtaining skilled labor there.

A SQUADRON OF NEW SHIPS.

An opportunity of comparison between some of our new vessels and those of European navies will be afforded shortly. The *Boston*, *Chicago*, *Atlanta* and *Yorktown* are to proceed to European waters as a "squadron of evolution," under the command of Admiral Walker, late Chief of the Bureau of Construction. These vessels are now fitting out and taking in supplies at the New York Navy Yard, and as soon as they are ready will start on an extended cruise, during which there will be full opportunity to test their qualities as cruisers and in every way, in fact, except in actual warfare, for which, fortunately, there is no opportunity offered at present.

TRIALS OF NEW VESSELS.

The gun-boat *Petrel* has been formally accepted by the Navy Department, and has been delivered to the Government at the Norfolk Navy Yard.

Owing to some defects in the indicators used at the first trial of the *Baltimore*, the horse-power developed by her engines was somewhat less than at first supposed, although the high speed made would have hardly indicated this result. The Department, however, has given permission for an additional trial to determine this point.

The test of the guns of the new dynamite cruiser *Vesuvius* was made October 9, the point to be determined being principally the rapidity of fire of the guns with which she is armed. As speed and not accuracy was the important point, blank shells or dummies were used. The first trial made was for distance, shots being fired from each of the three guns which landed respectively 960 ft., 1,050 ft., and 300 ft. beyond the mile limit. Then followed the test for speed. The contract demanded a rate of fire of 15 shots in 30 minutes, and this was successfully passed. The three air reservoirs were charged to 2,000 lbs. at the commencement, and five shots were fired from each gun. The following table shows the result:

Gun.	Time for Firing. M.	S.	Air Loss. Lbs.	Initial Pressure. Lbs.
Port	0	53	70	750
Port	1	45	74	750
Port	2	37	74	750
Port	4	15	76	750
Port	5	11	78	750
Center	6	06	105	750
Center	7	04	109	750
Center	7	55	114	750
Center	9	00	104	750
Center	9	58	96	750
Starboard	11	13	118	750
Starboard	13	03	112	750
Starboard	14	37	105	750
Starboard	15	45	120	750
Starboard	16	50	118	750

Projectile—Full caliber (15 in.) weight averaging 527 lbs.

The *Vesuvius* has now passed successfully the test for speed and for rate of fire, and the guns have also passed the test required for accuracy of aim and for range. She will probably be accepted and put in commission at an early date.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page* 473.)

CHAPTER XVII.

A RAILROAD PILE-DRIVER.

What has been said in the previous chapter in regard to piles and pile-driving, simply gives in an elementary form some of the general principles that should be known by any one handling a pile-driving machine. We will now take up pile-drivers as used upon the railroads in this country. The use of the pile-driver upon a railroad is not only for driving piles for foundations, retaining walls, and such ordinary purposes where they are to become permanent fixtures; but the great utility of piles upon railroads is the facility with which they can be used for repairing any washouts or breaks in the track, due to any cause. Consequently, the following are the requisites in a railroad pile-driver:

1. The pile-driver must be mounted upon a car, so as to be moved from place to place upon the track.

2. The leads must be so arranged as to fold back in order to allow of the passage of the pile-driver through the bridges upon the road.

3. Owing to the rapidity with which the work must be done in case of accident, or in the case of driving piles upon a road over which trains are running, the pile-driver should be so constructed that very little time need be lost in putting it in working order, and getting to work, and also in folding it up and making it ready for transportation. Many of the otherwise most excellent pile-drivers, or track-drivers, in this country, are rendered almost useless from the fact that their complication is so great that too much time is lost in putting them in working order, and then preparing them again for transportation.

4. As the principal use of the pile-driver is in driving piles across a washout or opening of some kind in the track, where it is impossible for the pile-driver to stand directly over the pile it is driving, some arrangement is necessary by which piles can be driven ahead of the point of support upon which the pile-driving car rests.

5. The pile-driver must be so constructed that it can drive not only a certain distance straight ahead, but also that it can be turned so as to drive a certain distance on each side of the track. In other words, it must be made to swing on a pivot for a certain distance each side of the center line, and also be able to drive ahead of itself a certain required distance.

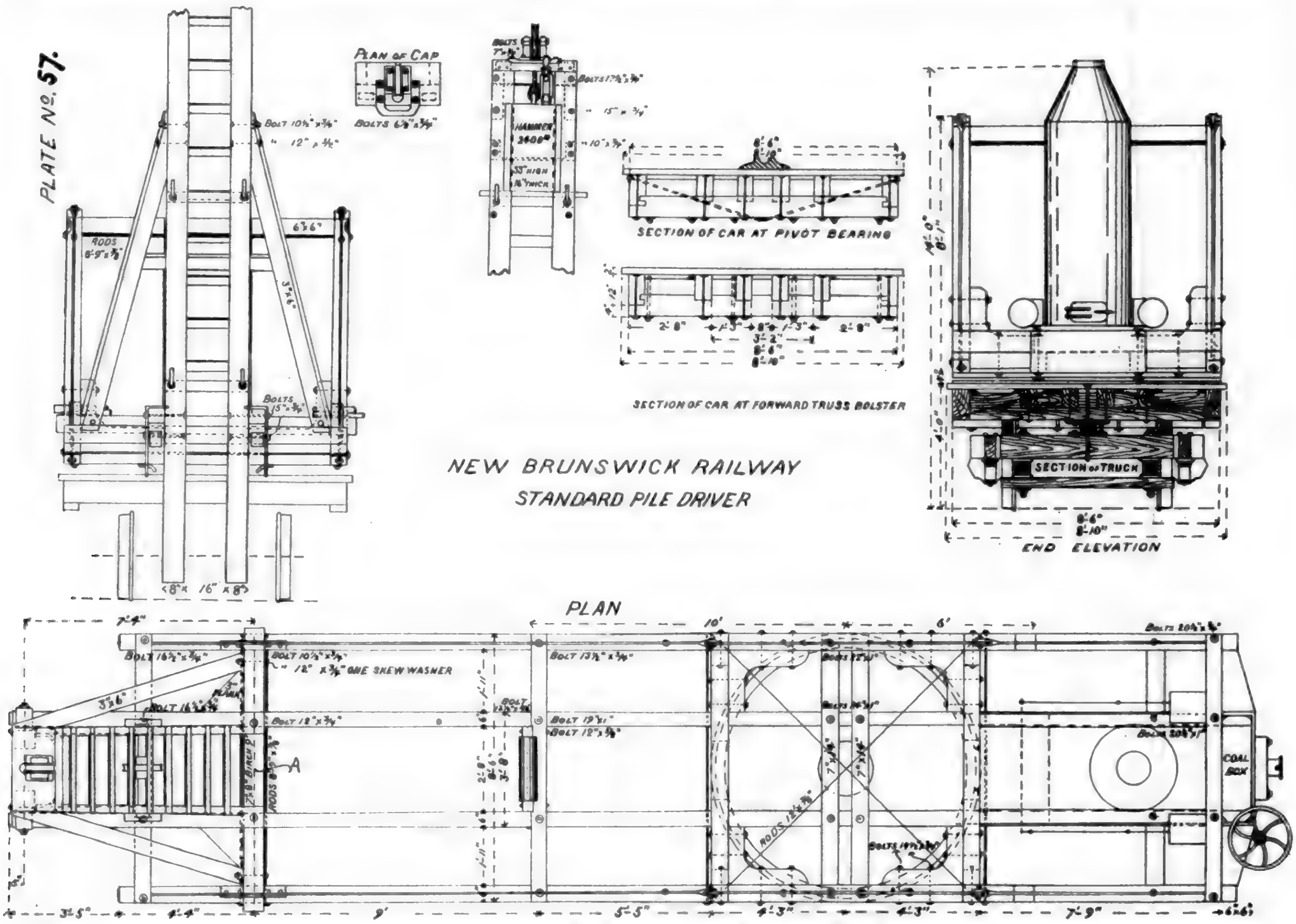
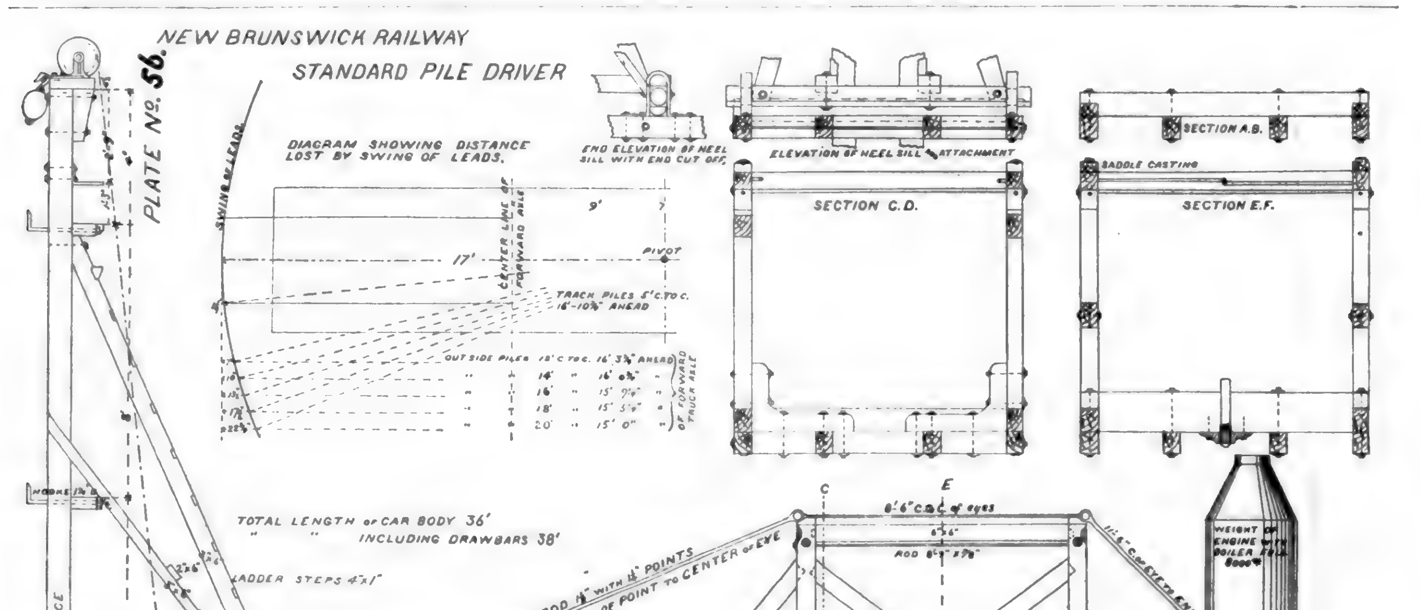
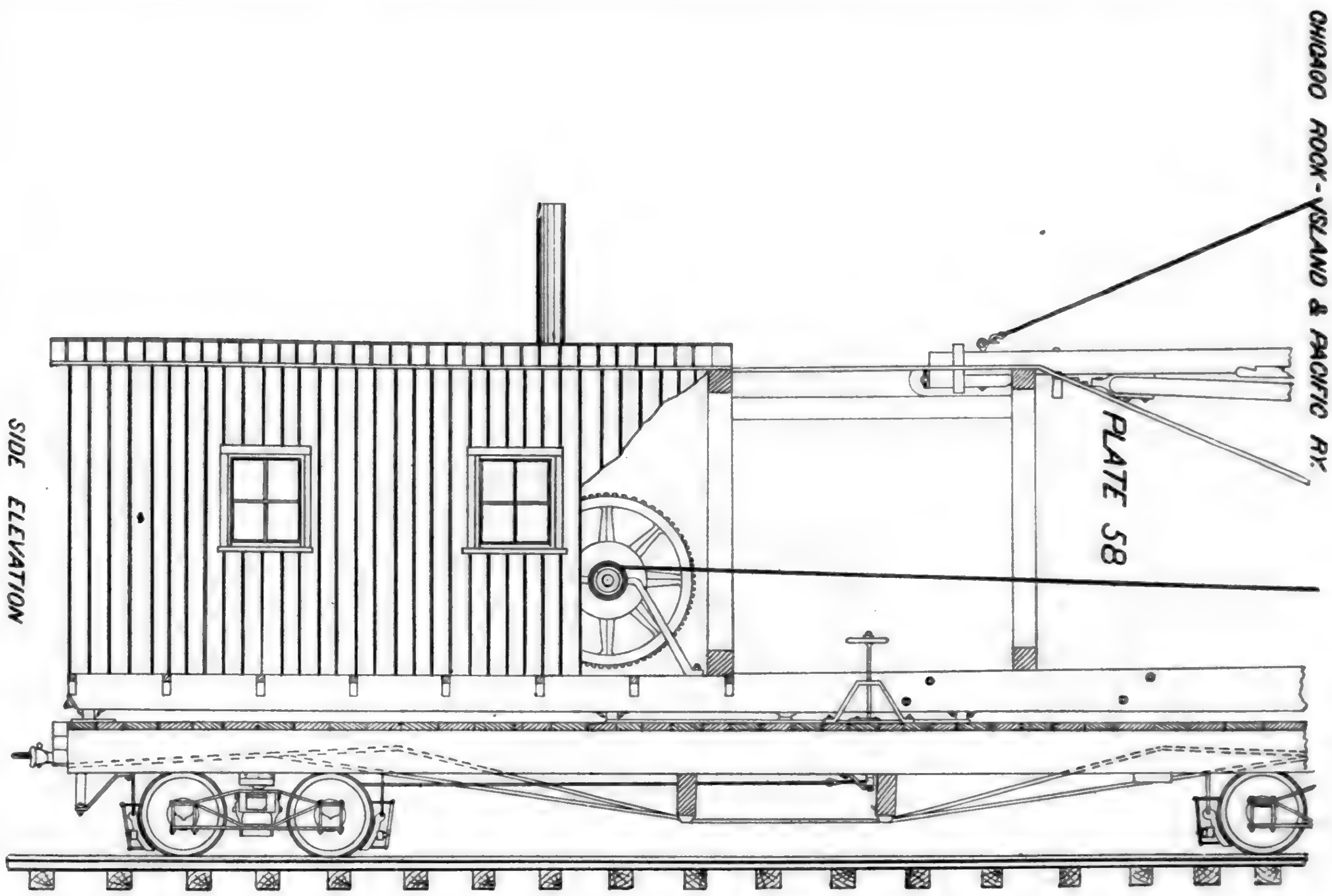


PLATE No. 57.
PLAN OF CAP
HAMMER 2400#
SECTION OF CAR AT PIVOT BEARING
SECTION OF CAR AT FORWARD TRUSS BOLSTER
NEW BRUNSWICK RAILWAY
STANDARD PILE DRIVER
SECTION OF TRUCK
END ELEVATION
PLAN
COAL BOX


NEW BRUNSWICK RAILWAY
STANDARD PILE DRIVER
PLATE No. 56.
DIAGRAM SHOWING DISTANCE LOST BY SWING OF LEADS.
SWING OF LEADS
CENTER LINE OF FORWARD AXLE
PIVOT
TRACK PILES 5' C. TO C. 16'-10½" AHEAD
END ELEVATION OF HEEL SILL WITH END CUT OFF.
ELEVATION OF HEEL SILL & ATTACHMENT
SECTION A.B.
SADDLE CASTING
SECTION C.D.
SECTION E.F.
TOTAL LENGTH OF CAR BODY 36'
" " INCLUDING DRAWBARS 38'
LADDER STEPS 4"x1"
TRUSS ROD 1¼" WITH 1½" POINTS
20'6" FROM END OF POINT TO CENTER OF EYE
HARDWOOD BLOCK
HARDWOOD ROLLER
8"x8" SPRUCE
6"x8" PINE
WEIGHT OF ENGINE WITH BOILER FULL 8000#



Plates 56 and 57 show full plans, with details, of the standard pile-driver of the New Brunswick Railroad. All railroad pile-drivers are to a certain extent of this general form. A few of the details in connection with this pile-driver appear to the Author to be of great excellency; therefore this one has been selected among others to illustrate the subject. As will be seen by an examination of the plate, the leads in this pile-driver are 22 ft. 6 in. long. The two braces that hold these leads in a vertical position are firmly bolted to the leads, and owing to the construction of the pile-driver, there is no necessity for unbolting them. The leads, together with the braces, turn upon a pivot point marked *A*. During transportation these leads are shut back upon the top of the gallows-frame shown in the drawing, and the forward trucks of the car are in the position shown by the full lines in the side elevation. When it is desired to put the driver in shape for work, the leads are drawn to a vertical position by means of the stationary engine, and the only thing necessary is to key them firmly in position to the bottom sill of the driver. These keys can be readily seen in the front elevation of the leads. The leads are raised and lowered entirely by means of the stationary engine, the hammer being placed at a certain point which is marked in the leads where it balances. Very little power is required to move them, and there is no danger of any accident. When the driver is in shape for work, the forward trucks are run back from their original position to a position shown by the dotted lines in the side elevation, thus allowing the driving of piles about 15 ft. ahead of the points of support.

The diagram on Plate 56 shows exactly the swing of the driver, and the distances lost by swinging each way from the center.

The following is the complete bill of material necessary for the construction of this driver. The great advantages connected with it are the extreme simplicity of its construction, the great strength attained at very little cost, and the quickness and ease with which it can be put in working order at any required place, together with the small amount of time lost in making it ready for transportation. Thus, if work is to be done in any place where the time is very limited, such as working between trains that are running with only a limited amount of time between, the amount of actual time lost in erecting and taking down this pile-driver is very small. This pile-driver was designed in all its details by Moses Burpee, Chief Engineer of the New Brunswick Railway, and for efficiency in work has given the greatest satisfaction.

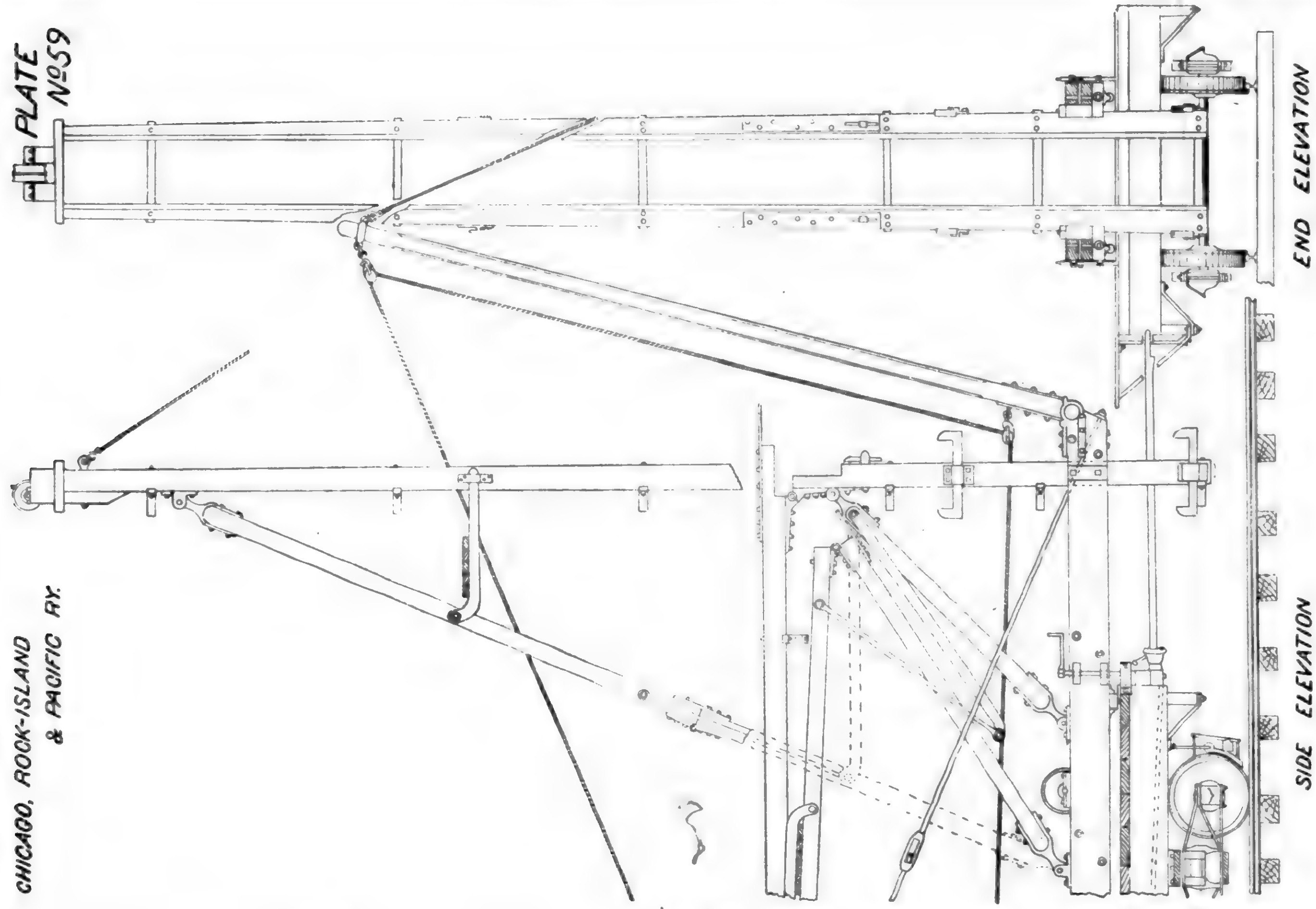
No. 33. Bill of Material for New Brunswick Railway Standard Pile-Driver. Plates 56 and 57.

Wood, Top Frame:

NO.	DESCRIPTION.	SIZE.	LENGTH.	TIMBER.
2.	Sills.	6 in. × 8 in.	39 ft. 5 in.	H. Pine.
2.	"	" "	35 ft. 6 in.	"
2.	Bolsters.	" "	16 ft.	"
4.	Posts.	6 in. × 6 in.	7 ft.	"
4.	Braces.	" "	9 ft. 2 in.	"
2.	"	" "	7 ft. 2 in.	"
4.	Struts.	" "	7 ft. 10 in.	"
2.	Center Pin Bolsters.	7 in. × 14 in.	8 ft. 6 in.	"
3.	Cross Sills.	6 in. × 8 in.	8 ft. 6 in.	"
2.	Planks.	2 in. × 8 in.	8 ft. 6 in.	"
4.	Sill Struts.	6 in. × 8 in.	2 ft. 3 in.	"
2	" "	" "	3 ft.	"
8.	Knees.	6 in. × 6 in.	3 ft. × 2 ft.	Hack.

Wood, Leads, etc.:

NO.	DESCRIPTION.	SIZE.	LENGTH.	TIMBER.
2.	Leads.	8 in. × 8 in.	24 ft. 9 in.	Spruce.
2.	Ladder Rails.	3 in. × 6 in.	16 ft.	"
2.	Lead Braces.	" "	13 ft.	"
9.	Ladder Steps.	4 in. × 1 in.	2 ft. 10 in.	"
1.	" "	4 in. × 4 in.	2 ft. 10 in.	"
2.	Lead Sills.	6 in. × 8 in.	8 ft.	"
2.	Blocks.	6 in. × 8 in.	8 in.	"
1.	Plank.	2 in. × 6 in.	8 ft. 6 in.	"
3.	Yokes.	4 in. × 11 in.	2 ft. 8 in.	Birch.
1.	Cap.	4 in. × 16 in.	2 ft. 8 in.	"
2.	Brackets.	3 in. × 7 in.	1 ft. 6 in.	"
1.	Heel Sill.	7 in. × 8 in.	9 ft.	"



Iron :

NO.	DESCRIPTION.	LENGTH.	SIZE.	REMARKS.
2.	Rods.	20 ft. 6 in.	1⅛ in.	1⅛ in. screw ends. Double
2.	"	11 ft. 6 in.	1⅛ in.	eye on the other end.
2.	"	8 ft. 6 in.	1⅛ in.	Single eye each end.
4.	Pins.	4 in.	1⅜ in.	Head and Nut.
2.	Rods.	12 ft.	⅞ in.	" "
8.	"	8 ft. 9 in.	⅝ in.	" "
4.	Bolts.	24 in.	1 in.	" "
4.	"	22 in.	1 in.	" "
2.	"	20½ in.	1 in.	" "
2.	"	19 in.	1 in.	" "
2.	"	16½ in.	1 in.	" "
2.	"	20⅛ in.	⅝ in.	" "
10.	"	18½ in.	¾ in.	" "
12.	"	16½ in.	⅝ in.	" "
24.	"	14⅜ in.	¾ in.	" "
2.	"	12½ in.	¾ in.	" "
2.	"	12 in.	¾ in.	" "
10.	"	10½ in.	¾ in.	" "
4.	"	10 in.	⅝ in.	" "
2.	"	8⅛ in.	¾ in.	" "
8.	Lag Screws.	9 in.	¾ in.	" "
24.	" "	8 in.	⅝ in.	" "
2.	Bolts.	17½ in.	¾ in.	" "
8.	"	15 in.	¾ in.	" "
4.	"	12 in.	¾ in.	" "
2.	"	10⅛ in.	¾ in.	" "
4.	"	10 in.	¾ in.	" "
2.	"	7 in.	¾ in.	" "
2.	"	6½ in.	¾ in.	" "
184.	Cast Washers.		⅝ in.	
28.	" "		1 in.	

In this Standard Pile-Driver of the New Brunswick Railway, which is shown above, a very important and ingenious mechanical detail is the sheave for the hammer line at the bottom of the leads, and the two smaller sheaves or rollers, with flanges, which embrace the outside of the main sheave, and are moved on that account with the main sheave by the change of the furniture of the line on the drum, both main sheave and the smaller ones being loose upon parallel shafts. The object of this is to allow the rope to run always in a true line and thus prevent wear upon the sides of the sheave, which is free to move laterally upon its shaft.

The engine used on this driver is a double-drum double engine made by Kendall & Roberts, Cambridgeport, Mass., fitted with friction clutches and also foot-brakes. This engine has given entire satisfaction during the time it has been in use.

The driver complete cost $2,000, including $275 duty on the engine. The rapidity with which it can be put in working shape or lowered for transportation, and the generally satisfactory manner in which it does its work have proved the advantages attending its details of design and construction.

Plates Nos. 58 and 59 give the plans of the Pile-Driver used upon the Iowa Division of the Chicago, Rock Island & Pacific Railway.

In designing this driver—as in the one previously described—the objects aimed at have been :

1. Rigidity and stability while at work.
2. Ease and rapidity of changing from a position suitable for work to one suitable for transportation.
3. Simplicity and fewness of parts.

The main brace, which holds the leads in an upright position, is fastened at both ends with a pin-joint and has a hinge-joint in the center, as shown in plate 59, side elevation. The leads have a hinge-joint at the height of the gallows-frame, and the leads when in shape for transportation are folded back upon the gallows-frame, as shown in the side elevation. The main brace remains fastened at each end, but doubles at its center and folds under the leads as shown.

The boom projecting in front of the car is for the purpose of raising and lowering the leads. This boom is connected with the car-body by means of a joint, which allows of free movement in a vertical plane. At each end of the boom is fastened a snatch-block. The raising line runs from the winding drum through the lower snatch-block, from there up the boom through the upper snatch-block and thus to the head of the leads. From the upper end of the boom a guy-line is run forward and made fast to the track. Then by taking in the rope on the drum, the leads are brought into an upright position, and by the reverse

operation they are lowered. When the leads are raised the only thing necessary for locking them is two keys on the front, shown in the end elevation.

In driving sheet-piles for the sides of foundations, etc., some of the details of the regular ordinary pile-driving machine have to be changed to meet the requirements.

Sheet-piling usually consists of 2 in. or 3 in. plank driven side by side so as to form as tight a joint as possible. In order to crowd the piles as closely together as possible, they should be sharpened entirely on one side and the side or edge not sharpened placed next the pile last driven. In some cases the plank are tongued and grooved so as to not only make the joints more perfect, but also to partially act as a guide to each succeeding pile.

In driving sheet-piling, also, it is customary to drive first a double row of guide-piles. These piles are usually ordinary square or round timber, and are driven 6 ft. or 8 ft. apart in the line of the wall.

The distance between the two rows of guide-piles is sufficient to allow of the bolting to the inside of the outside row and the outside of the inside row, parallel horizontal timbers called wales, usually about 6 in. × 10 in. The distance between these wales is sufficient to just allow of the passage of the sheet-piling.

Sheet-piling should be supported every 6 ft. or 8 ft. when the earth has been removed from the inside. The distance between these lateral braces or additional wales will in every case be determined by the nature of the supported material, and the amount of pressure that is necessary to sustain the piling.

In driving sheet-piling some arrangement must usually be made so that the leads of the driver do not interfere with the previously driven piles, and also that the piles may be driven nearer to walls, etc., than is possible with the ordinary driver as described. These two points are usually secured by giving such a form to the hammer that only one lead is necessary, the hammer sliding upon the front of that lead.

In driving false works for bridges, etc., it is very often necessary to drive some distance below the level upon which the driver stands. This is accomplished in two ways:

1. By using a "dolly," or follower, spliced to the top of the pile as has been described.

2. By using a specially constructed lead and hammer so arranged that the lead can be lowered below the track level and the hammer slide upon it.

Upon the Iowa Division of the Chicago, Rock Island & Pacific Railway the following arrangement has been in use some years and has given satisfaction: The lead is in the form of an iron rod which passes through the hammer and rests on the top of the pile. This rod descends with the pile sliding through guides attached to the body of the driver.

There is a simple mechanical device on the guides that prevents the rod from being raised from the pile with the hammer.

In addition to what has been said in regard to banding the heads of piles to prevent their splitting and breaking, we wish to call attention to the following: The disadvantages connected with the use of bands are:

1. The time lost in placing them in position.

2. The slight effect they have in preserving the piles under some circumstances.

3. The time lost and difficulty attending their removal. This last is by far the most serious objection. In order to accomplish the object aimed at in the use of the bands, viz., the preservation of the piles while being driven, there has of late years been used an iron cap. This iron cap is made concave on both the top and bottom. The bottom is made to fit over the head of the pile, which is beveled off to the proper amount to receive it. In the cavity upon the top of the cap is placed a piece of hard wood which serves as a cushion to receive the hammer blow. The face of the hammer is made of suitable form to match the cap. By this arrangement the head of the pile is well preserved during the process of driving.

The cap is constructed by grooves in the sides the same as the hammer, so that it may be held firmly in place and slide in the leads. By this means it offers great assistance to the guiding of the pile and insures the head being in the proper place to receive the blow. Upon each side of the cap are two lugs, and upon corresponding sides of the hammer are two short chains securely fastened. These chains are of such a length that when the hammer rests upon the cap the chains can be made fast to the lugs and thus the cap raised by the hammer line. This renders it exceedingly easy and economical to remove and handle the cap after a pile has been driven, and does away with the third objection to banding the pile heads.

In closing these brief remarks upon piles, we wish to call attention to one other point:

There is always the possibility that at some time during the life of every railroad an exceptionally heavy freshet will wash out the track and some of the superstructure in a number of places at the same time. In case of any break in the track of a railroad that prevents the passage of trains, *time* is the one point to be considered in the repairs. To get the track open is the one object to be worked for. Very few roads have more than one track pile-driver at their command, even in an emergency, and even when more are available it is often impossible to get them to the point where they are needed.

It is, however, usually possible to procure as many ordinary stationary drivers as needed. These drivers can be mounted upon an ordinary flat car and made ready for use in a very short time. The method is as follows:

Take a platform car and across each end place a piece of timber say 12 in. × 12 in. The timber at the back end need be no longer than the width of the car, but the one on the front end should project 3 ft. or 4 ft. beyond the car body on each side. This front timber is to be securely lashed to the frame of the car body, and the lashings are to be tightened up by means of a wedge. On top of these two cross-timbers place four sticks about 16 or 17 ft. longer than the car body, and about 8 in. × 10 in. in size. The back ends of these longitudinal pieces should be together near the center line of the car and the other ends should project in front. These front ends are to be spread apart sufficiently to include within their outside limits a distance each side from the center of the track greater than the side distances of the outside piles to be driven. These longitudinal timbers must be firmly lashed to the car body and secured by wedges. These wedges are driven between the timbers and the lashings. This frame is then floored over with a sufficient number of plank to enable the men to pass back and forth, and also to hold the frame of the pile-driver. This frame is then set upon the flooring, and secured in any manner that will insure its upright position and allow of its being thrown to the right or left as may be necessary. If the stationary engine is not on the lead frame it can be put upon the rear of the car, and it, together with the necessary fuel, will serve as a counterbalance to the leads and hammer.

It is often a good plan to run out guy-ropes each side from the top of the leads in order to render them secure when a cross pull is brought upon them in lifting the piles into place.

In case no small, suitable stationary engine is available, the hammer can be raised by attaching the line to the draw-bar of a locomotive. This method is slow and in itself very expensive. The matter of expense, however, is one of minor importance provided the work can be pushed.

A CORRECTION.

In Chapter XVI, in the October number of the JOURNAL, page 473, the equation written:

$$W \times H \frac{P^2 \times L}{4\,P\,S}$$

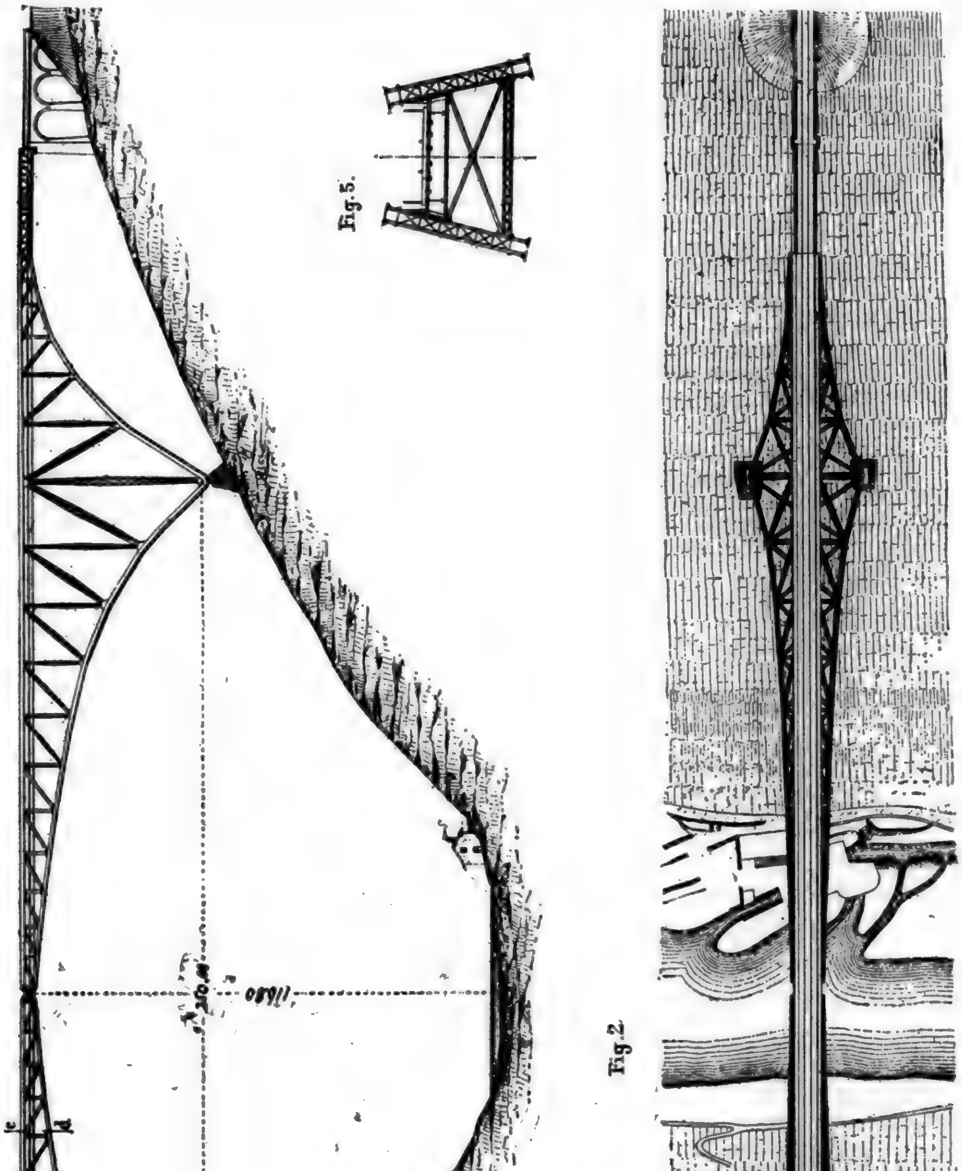
should read:

$$W \times H \frac{P^2 \times L}{4\,E\,S},$$

and in the sentence following the word *multiplied* should read *employed*.

AUTHOR.

(TO BE CONTINUED.)



THE VIAUR VIADUCT.

DESIGNED BY THE SOCIÉTÉ DE CONSTRUCTION DE BATIGNOLLES.

THE VIAUR VIADUCT.

(From *Le Genie Civil.*)

THE plan for the Viaur Viaduct, a model of which is seen in the Paris Exposition, has been made for the crossing of the valley of the Viaur on the new line from Carmaux to Rodez, and is the result of a competition arranged by the Government for the design and construction of this work.

The Commission of engineers appointed to examine the plans submitted by different constructors has chosen that submitted by the Société de Construction des Batignolles, and this selection has been approved by the Minister of Public Works, who has ordered the construction of this important bridge by the company named. The engraving shows the general plan and arrangement of the work. In these illustrations, fig. 1 is the general elevation; fig. 2 a plan; fig. 3 a section on the line *e f*; fig. 4 a section on the line *a b*; and fig. 5 a section at *c d*.

The bridge consists of a metallic arch composed of two symmetrical halves joined at the center. Each of the halves has the form of a triangle, with two curvilinear sides, and with the apex, which is opposite the rectilinear side, placed below, giving the general appearance of an arch prolonged on each side to the abutments by a second and smaller triangle. The sides of the triangle formed by each half of the central arch are chords united by rigid braces composed of vertical or oblique columns.

The metallic structure rests upon masonry piers through the medium of flexible joints, and at the extremities nearest the ends of the bridge supports a short metal truss, the other end of which rests upon the masonry abutment which forms the end of the bridge. This arrangement has been adopted in order to allow for any slight motion in the ends of the central truss.

The two main trusses are inclined to the vertical in such a way as to present the resistance necessary for the stability of the structure. At their upper end they support cross girders upon which the track rests. Cross-bracing placed in the vertical plane, or in the plane of the lower chord, completes the structure. This arrangement presents the following advantages:

1. The presence of the three flexible joints permits an exact determination of the thrust, and the strains to which the different parts of the structure are submitted can be exactly determined, since there are no superfluous parts.

2. No strains will be developed either during construction or in service, except those which result from the weight of the bridge itself, the moving load, and the wind.

3. The flexible joint in the center permits the adjustment of the arch without trouble and without submitting any part to abnormal strains, which are very difficult to determine, and which are always caused in the erection of a continuous arch.

4. The whole arrangement diminishes the thrusts, enables the constructor to divide the strain better between the chords, and facilitates the erection. During the erection, the central portion is held in equilibrium, partly by the weight of the outer ends of the triangles, and partly by braces or cables properly secured, the action of which will not at all modify the strains when the construction is completed.

5. The joints give full freedom for expansion and contraction of the structure due to the changes of temperature.

The possible variations under the action of vertical loads, of the wind, or of expansion and contraction, have been worked out with very great care. They are very slight, and are, indeed, less than those of the largest structures of this nature now in existence. The proportions are so arranged that the arch cannot open at the center under the action of the most violent winds, and, moreover, to prevent any danger on this point, the central joint or key will be furnished with additional links or connections which will hold the two sections of the arch at this point, without interfering at all with the free movement of the joint.

The principal dimensions of this work are as follows:

Total length of viaduct	460.00 meters	(1,508.80 ft.)
Length of metallic structure	410.00 "	(1,344.80 ")
Span of central arch	250.00 meters	(820.00 ft.)
Distance from end of central arch to abutment on each side	80.00 "	(262.40 ")
Rise of the arch	45.40 "	(148.91 ")
Height from bottom of the valley to rail	116.80 "	(383.10 ")

The opening of 250 meters (820 ft.) of the central arch will give this bridge the longest span of any work existing in France. The Garabit Viaduct is higher, the rail being 122 meters (400 ft.) above the bottom of the valley, but the great arch in that viaduct is only 165 meters (541 ft.) span. The span, however, of the Viaur Viaduct is exceeded in the great Forth Bridge now under construction in Scotland.

FRENCH CRITICISM OF OUR WAR-SHIPS.

ADMIRAL DE COULSTROM, accompanied by the field officers of the *Aréthuse*, recently visited Cramp's ship-yard in Philadelphia. The Admiral is reported to have made the following criticisms of the *Vesuvius* and *Baltimore*:

"The pneumatic guns are wonderful inventions," he said, "but their value is undetermined. Their destructiveness is unquestionable if the boat can reach within throwing distance of the boat to be attacked. Here is where the trouble comes in. An iron-clad can completely destroy it, with its long-range gun, before it is able to get in range with it. With this point the objectionable feature stops, for, from practical demonstration, it has been shown that the dynamite shell can blow the largest vessel afloat into a thousand atoms, if it falls within 20 ft. of it in the water."

The Admiral criticised the unprotected upper gun decks of the *Baltimore*. "Men will not stand to the guns," he said, "without more substantial protection in front of them. I have tried it." He praised the efficiency of the machinery, but severely criticised the accommodations of the Admiral's quarters. "Why, they are like a prison," he said. "They are unnecessarily small. Here is a shaft which could be easily placed 20 ft. further forward and give double the room. The room is on the gun deck. It ought to be where the Captain's is—where he can see the working of the ship. As it is now, he is off the earth. Here you have it so arranged that the Admiral eats by himself, and so does the Captain. I eat with my field officers."

The Admiral praised the other appointments of the new cruiser. He said that the French Government has just had built a steel cruiser, named the *Forbin*, which is equally as fast and well arranged as the *Baltimore*. It has attained the speed of 20.6 knots per hour, "and," he said, "with the utilization possible of extra power, we hope to greatly increase this record."

IS GASEOUS FUEL ECONOMICAL?

AT a recent meeting of the Iron & Steel Institute, held in Paris, Sir Lowthian Bell read a paper on Gaseous Fuel, which excited an animated discussion. His conclusions were that for every 100 units of fuel burned there is utilized by coal 83.93 per cent. of its heat; by producer-gas 71.14 per cent., and by water-gas and its producer-gas 78.80 per cent.

In reply to this, it was said that there was no general rule as to solid fuel being more economical than gaseous fuel; in some cases it was better to have the one and sometimes the other. It was also known that a certain amount of the heat energy of the fuel must be expended in the process of the conversion of the gas. The case of a large mill in Italy was cited in which there were 22 boilers heated by gas made in producers, in which it was found there was no economy.

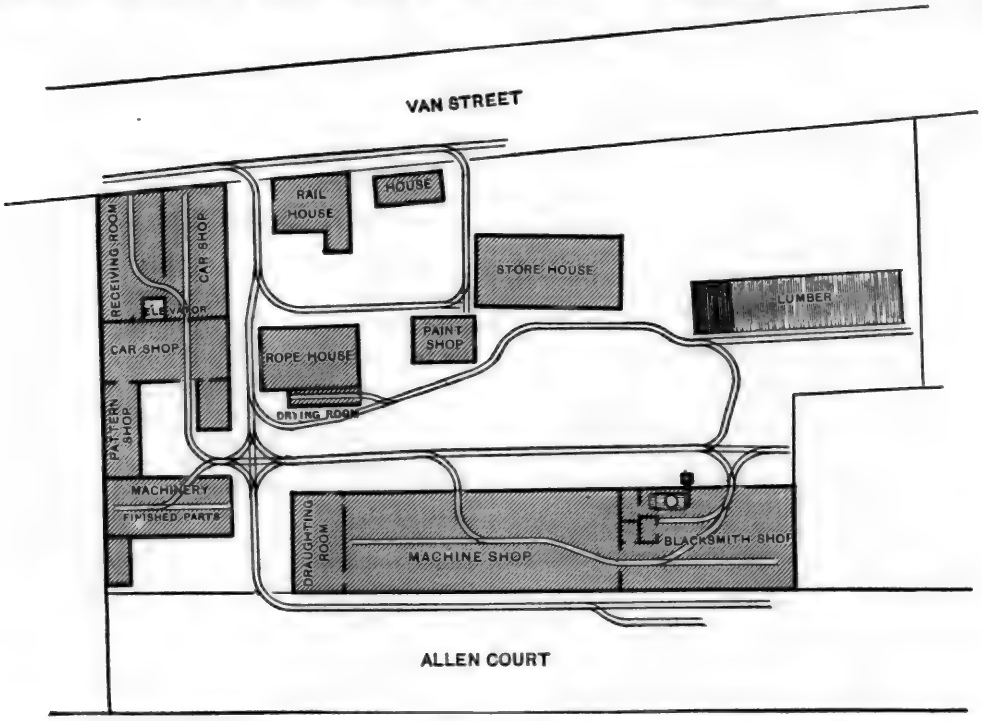
On the other hand, it was said that while a certain amount of the heat energy of the fuel must be expended in the process of conversion into gas, it must be remembered that it was not possible to burn solid fuel without introducing something like twice the quantity of air theoretically required for its combustion from the fuel and insure its being supplied with a sufficiency of oxygen. Moreover, this supply of air had to be drawn in by a strong chimney draft, which causes a rapid withdrawal of the

heated currents, and so a further loss was sustained. With gas it was not necessary to have so large an excess of air present, and very little chimney draft sufficed, and consequently there was a comparative gain. Further than this, the gas could, when required, be heated before combustion by means of the outgoing products, but with solid fuel this was impossible.

Another speaker said that the object in using gaseous fuel was to convert it into a more manageable form, and its employment might be advantageous when the heat was needed under exact regulation, and with a minimum of labor and dirt. A temperature was obtainable with the gaseous fuel which was absolutely unattainable with solid fuel, and that proved that when high temperature was required gaseous fuel was the only form in which to use fuel, and when heat was required to be under control, gas offered the readiest means of regulation.

The discussion, of course, had no reference to the use of natural gas, which does not exist in quantities which make its use practicable in England.

Fig. 1.



The C. W. Hunt Company's Narrow-Gauge Railroads.

PROBABLY there are many of the generation of young railroad men who are so rapidly filling the places of those who have crossed the summit of the divide which separates the first half century of our lives from that greater or lesser fraction of 50 years which remains to us on the descending portion of the journey of life, who took no part or interest, or do not even remember the controversy over the advantages and disadvantages of narrow as compared with standard-gauge railroads, which was started by a paper on "The Railways of the Future," that was read by Mr. Robert Fairlie before the British Association in 1870. There seemed to be contagion in the fallacies which were presented to that learned body, so that they spread like a disease. With one exception, the railroad and engineering papers everywhere became advocates of the narrow-gauge system, and many roads were built and much money was wasted as a consequence of the delusions, which so many at that time seemed to take pleasure and comfort in believing. It is not intended here to review the discussion of this subject any further than to quote from a pamphlet, before us, describing the C. W. Hunt Company's system of narrow-gauge railroads,* in which it is said that "it was designed for the special work of handling material in and around manufacturing establishments, and it is not intended to carry passengers, or to be in any way a competitor with the standard-gauge system." In the pamphlet the discussion of years ago is summed up very concisely in a sentence, in which it is said that "the fallacy in the common arguments for narrow-gauge railroads was, that the width between the rails was taken as the base of the system, whereas that is little more than an incident, and the dimensions of the railroad must be governed by the speed of the trains and the size and weight of the loads which the traffic requires." This recalls a discussion which occurred between a narrow-gauge enthusiast and a skeptic years ago, in which the believer asserted that nature in forming the deep cañons in the West had made them of a width which was just wide enough to admit a narrow-gauge car, but would not admit one of greater width. The disbeliever expressed incredulity, and retorted that if you wanted to build a railroad to run into a rat-hole, that obviously a narrow gauge was essential. Now, metaphorically speaking, the C. W. Hunt Company have devised a system of railroads to run into rat-holes, or, in other words, for service in and about manufacturing establishments of various kinds—mines, plantations, navy-yards, military reservations, etc. A plan of their own works at West New Brighton, Staten Island, N. Y., fig. 1, furnishes a good example of the use of such a road. The reasons given for the adoption of a narrow gauge for such lines

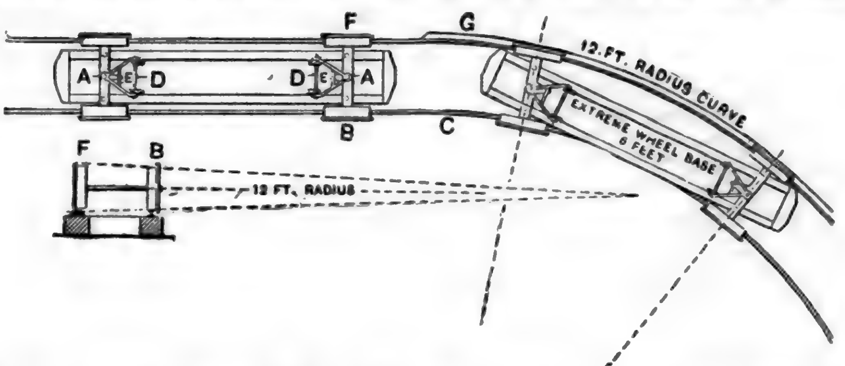


Fig. 2.

* Liberal quotations have been made from this pamphlet in preparing this article.

are the following: The curves can be of short radius; turn-tables can be dispensed with; the tracks can be easily run in doorways and confined places; obstructions can be readily avoided; cars can be run anywhere that a team can be driven; excluded, and only wheels rigidly fastened to the axles are used." In this short sentence the illusion concerning the use of loose wheels, which has the demerit of being immortal, is finally dismissed.

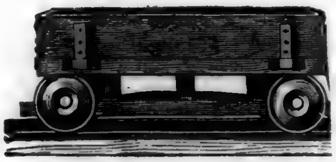


Fig. 4. Stone Car.

Fig. 5. Self-dumping Car.

Fig. 6. Side-dumping Coal Car.

Fig. 7. Pig-iron Car.

Fig. 8. Charging Car for Furnaces.

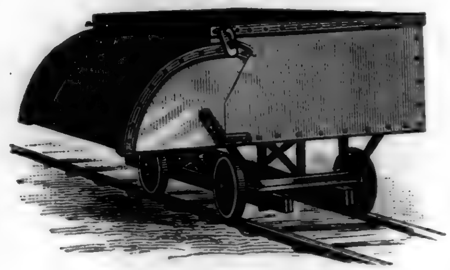


Fig. 9. Car for Hot Coke.

locomotives can be used with great advantage; any load that the business requires can be carried, and the expense of operation is small. These reasons all seem to be sound, and only need to be stated to be accepted.

As mentioned before, for much of the service for which the Hunt system of roads has been designed, curves of short radius

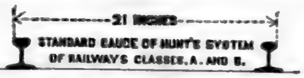
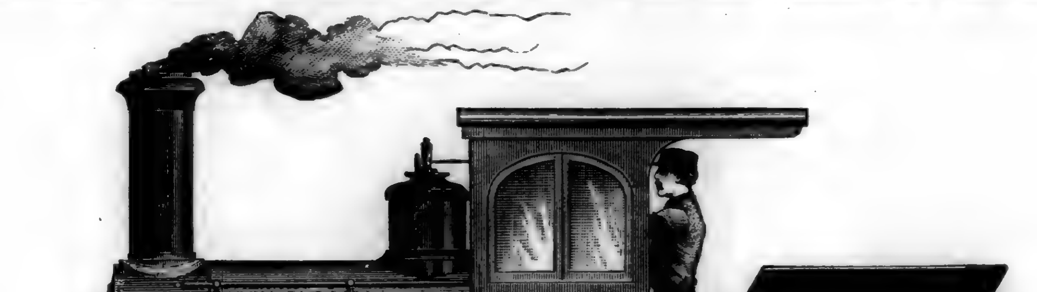


Fig. 3.

are absolutely essential. The system was, therefore, arranged for a minimum radius of 12 ft., measured from the center of the circle to the center of the rails. As many of the cars used are intended to be moved by hand, it was desirable to reduce the resistance on curves to the smallest possible amount, and for several years a study was made of this subject. Almost

The resistance of cars, which is ordinarily due to the curvature of the track, they say, arises, first, from the difference in the length of the inner and the outer rails, so that if the wheels are of equal diameters, either those on the inside or those on the outside of the curve must slip circumferentially; second, from the divergence of the curve from a straight line, compelling the wheels to slide laterally; and third, from the friction of the wheel flanges against the rails. It is well known that a frustum of a cone will roll in a curved path as freely as a cylinder will roll in a straight line; but to do so the axis of the frustum must conform to the positions of radii of the curve. If, then, a pair of wheels were made of unequal diameters, so that their rolling action would practically be the same as that of a frustum of a cone, and if the axle could adjust itself radially to the curves, then the wheels would roll on a curve as easily as on a straight line. To meet these conditions, the Hunt Company arranges

Fig. 10.



every device for reducing the friction of the wheels on the curves was examined, and quite a number of them were tried. It is said further that "wheels running loosely upon the axles are so thoroughly bad mechanically, that they have been rigorously

the rails of curves so that the wheels on the outside will run on their flanges, and in order that the axles may assume radial positions to the curves, the plan of construction represented by fig. 3 has been adopted. In this a pair of wheels, rigidly fast-

Fig. 11. Ordinary tee-rail on a plank floor.

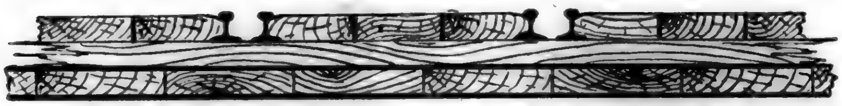


Fig. 12. Guard rails, used to make the rail heads even with the surface of the floor.

Fig. 13. Flat rail on a floor with the space filled in.

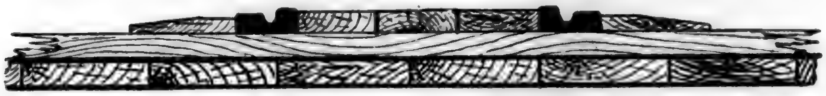


Fig. 14. Grooved rail on a floor with the space filled in.

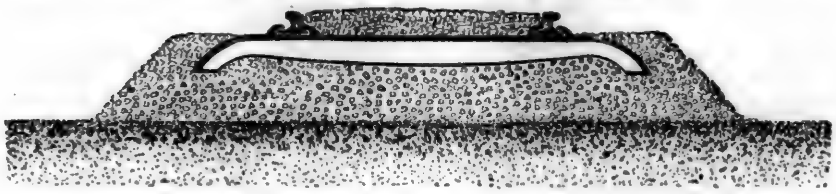


Fig. 15. Ordinary tee-rail with iron ties for a permanent railway.

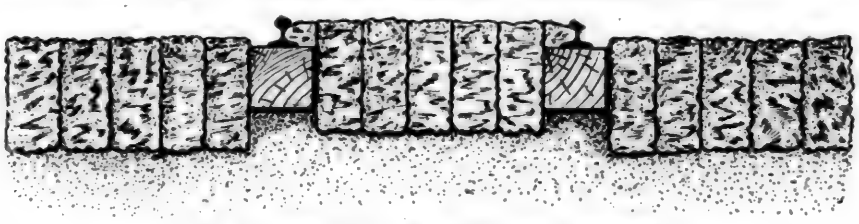


Fig. 16. Ordinary tee-rail with longitudinal wooden ties.

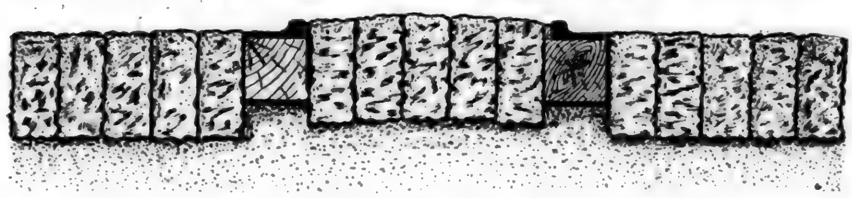


Fig. 17. Flat rail with longitudinal wooden ties.

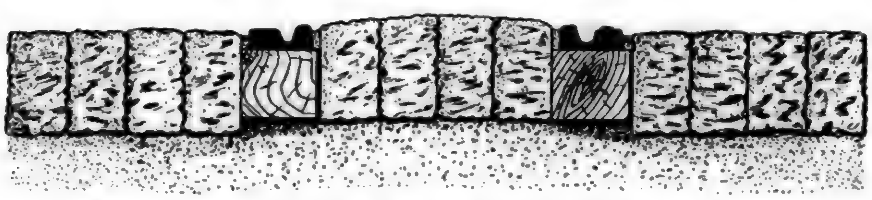


Fig. 18. Grooved rail with longitudinal wooden ties.

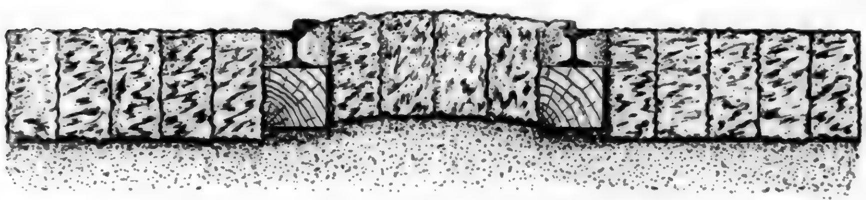


Fig. 19. Johnson patent rail with longitudinal wooden ties.

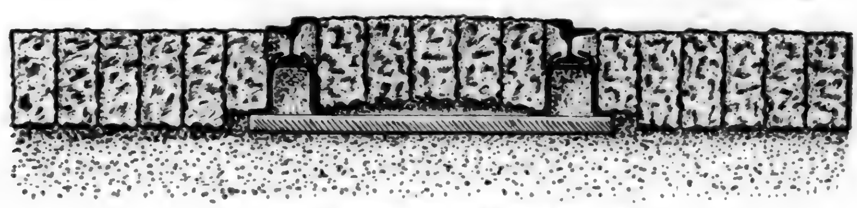


Fig. 20. Johnson patent rail with iron ties.

ened to the axles, is placed at each end of the car. These run in bearings that are connected together and have a central pivot, *A*. The car is hung on the bearings by links, so that on curves the axles are free to turn in a radial direction around the pivots *A A*, as shown on the right side of fig. 2, somewhat as the front axle of a wagon does about its king-bolt. The axles are attached by the pivots *A A* to the triangular-shaped frames *E E*, which are hinged to the car at *D D*, so that the pivot *A* can move vertically, but not horizontally. With this arrangement, if the flanges were on the inside of the rails, as they usually are, if the car ran on a curve, the flange of the outside wheel *F* would impinge against the rail, and the resistance thus encountered would tend to push that wheel backward, and thus cause the axle to move about the pivot *A* in a reverse direction to a radial position. For this reason, in the Hunt system, the flanges of the wheels are placed on the *outside* instead of the inside of the rails. With this arrangement, when the car, fig. 2, running on the straight track, reaches the curve, the flange of the wheel *B* strikes the rail at *C*. The pressure against the flange thus tends to force the wheel *B* backward into a radial position on the curve. At the same time the outer wheel runs on its flange—the outside rail of curves being of a special form for that purpose—and the larger diameter of the flange keeps the axle in a radial position during the rest of the passage of the curve. The treads of the wheels are coned, being larger on the inside than on the outside. As

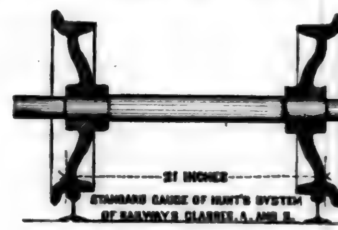


Fig. 24.

there is a play of 1 in. between the flanges of the wheels and the rail, the coning on the wheels causes the axles to adjust themselves exactly at right angles to the track at every point.

In the attempts which have heretofore been made to solve the mechanical problem of constructing cars to run around curves easily, the effort has usually been made to solve one of the difficulties only, and all of them have had the radical defect that the more perfectly they worked on the curves the more imperfectly they worked on the straight track, and as there is much more straight than curved track on most lines, the arrangements for saving friction usually caused a greater loss on the straight track than was saved on the curves.

To meet the various requirements, three different classes of railroads have been devised, all of them with a gauge of 21 in., measured on the outside of the rails, as shown in fig. 3. On roads designated as class *A*, the cars are intended to be moved by hand, and the loads vary from 1,000 to 3,000 lbs. The rails are of very light section. The curves are of 12 ft. radius or more, and the cars have no couplings nor brakes. Figs. 4–9 represent cars for different purposes used on this class of roads.

On class *B* roads the cars are intended to be handled by locomotives, horses, or men. The cars have couplings and brakes unless otherwise ordered, and the loads vary from 2 000 to 6,000 lbs. The curves are 12 ft. radius or more, and the rails are of heavier section.

Class *C* is the same as class *B*, excepting that the loads are 16,000 lbs. and the curves 30 ft. radius or more, and the rails are made to suit the work.

The problem of designing a locomotive for running on curves of 12 ft. radius, which at the same time would have adequate tractive capacity, was a difficult one. The Hunt Company has sought a solution of it by adopting a double-truck locomotive, represented by fig. 10. This has two trucks, each provided with a pair of cylinders. Each truck is connected to the engine by a hollow center-pin, through which the steam is conducted to the cylinders by means of patented flexible joints, which adapt themselves to the necessary motion of the trucks in turning curves and in passing over inequalities of the track.

The wheels have the flanges on the outside of the rails, as shown in fig. 24, and owing to the narrowness of the gauge, and to give greater accessibility to the journals, they and the frames are placed outside of the wheels, and disk cranks are connected to the axles outside of the frames, and the valve-gear is outside of the cranks. This makes all the parts very accessible and easy to inspect.

Fig. 21.

Fig. 22.

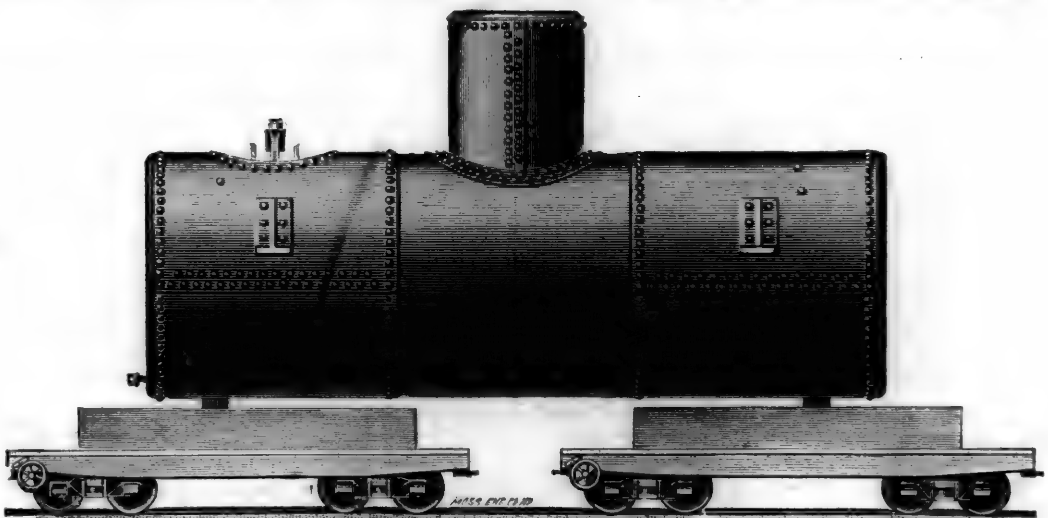
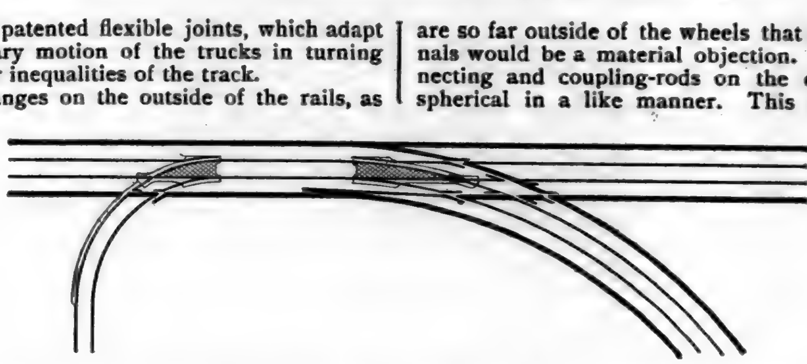


Fig. 23.



The main boxes for the axle bearings are made of bronze, and are turned on the outside to the form of part of a sphere which fits into a similar socket, and allows the bearing to turn, as the axles may be distorted in passing over uneven track, thus giving in all cases an evenly distributed load on the axle. If one wheel runs over an obstruction, the axles are thrown out of line with each other, as also are the crank-pins. The spherical bearings in this case turn slightly in the supporting boxes, and thus keep an even pressure on all parts of the axles and pins. In the engine described, the bearings of the crank-pins are so far outside of the wheels that the distortion of the journals would be a material objection. The bearings of the connecting and coupling-rods on the crank-pins are also made spherical in a like manner. This brings a perfectly square pressure on the bearings, no matter what the length of the bearing or the distortion of the axles may be, in running over an uneven track.

Professor Sweet's patented balanced valves and a form of "radial" valve-gear designed by Mr. Hunt are used.

Two kinds of boilers have been applied to these engines;

One, shown in fig. 10, is a modification of an ordinary locomotive boiler, but having a circular instead of the ordinary square fire-box. The other style of boiler has return flues, which brings the chimney out over the fire-box and cab, instead of at the front end.

The boilers are carried on independent plate-iron frames, and their arrangement gives plenty of room in the cab, and the space for the engineer is thus ample and convenient for him to see everything that is going on. If smoke is objectionable, anthracite coal, coke, or crude oil may be used for fuel.

Figs. 11-20 represent cross-sections showing different methods of laying the track. It will be seen that having the flanges outside of the rails gives an advantage from the fact that the ballast or other material forming the roadway may be laid between the rails flush with the top of their heads, which thus gives much better drainage and offers less obstruction to vehicles in and about works of different kinds. Frogs, switches, and crossings must, of course, be specially adapted for wheels with outside crossings.

As all the rolling stock for these roads is equally well adapted to run either way, no turn-tables are used.

The cars for carrying heavier loads, and to be hauled by locomotives, are made with trucks of the ordinary "diamond" pattern. The flanges of the wheels are, however, outside of the rails, as shown by figs 21 and 24. Fig. 22 shows the method of carrying heavy loads on two of the light cars.

In case it is desirable to connect a narrow-gauge system of road with one of the standard gauge, the rails of the former can be laid between those of the latter, as shown in fig. 23. Locomotives of either gauge can then move cars of their own or a different gauge on the double track.

The C. W. Hunt Company makes a specialty of the construction of this class of railroads and rolling stock, and may be addressed for information at their office at 45 Broadway, New York, or at their works at West New Brighton.

Some Scattering Notes.

THE shops of Bement, Miles & Company, in Philadelphia, are shortly to be enlarged, the firm having felt the necessity of increasing their facilities for large and heavy work. The design is to construct an addition to the old building 150 ft. in length by 85 ft. wide, with an L 93 × 100 ft. in size. The new shops will be covered by a roof carried on trusses spanning the entire width, so that there will be no columns or other obstructions in the way. When this is finished, the rear wall of the present main shop will be torn down and the roof extended over to the wall of the foundry, making that portion of the shop the same width as the new part. The main shop will be then 494 ft. in length by 85 ft. in width. In the new shop, the main portion will have on the south side two galleries 26 ft. in width, which can be used for lighter machinery and tools, and the wing or L will also have two galleries 30 ft. in width. This will leave in both shops a clear space of 60 ft. in width extending to the roof, and giving room for the erection of the largest machinery for which there is likely to be any demand. In this shop there will be two 30-ton traveling cranes, having a span of 60 ft., and these can be used to move their loads to any part of the shop, not only furnishing a very convenient arrangement, but making possible a considerable economy of time and labor in the building of heavy machinery.

THE Dow positive piston pump is meeting with very good success, the Kensington Engine Works in Philadelphia having many orders on hand for the pump, including a number of second and third orders from parties who are already using it. Some interesting experiments have recently been made with this pump to show its capacity for running at high speed, and 970 revolutions per minute have been attained. The capacity of the pump, as a high-duty pump as well as for ordinary work, has now been pretty well established. The largest pump of this kind yet constructed is now being made; it is a 16-in. pump and will deliver 1,800 gals. of water per minute in operation.

THE new shop of Pedrick & Ayer, in Philadelphia, is a model of good design and arrangement for the purpose for which it is used. In the center of the floor there are two clear openings extending to the roof and giving abundant room for work of almost any size or height, while around the shop, as a second story, is a wide gallery used for the lighter tools. The shop is well equipped with tools of all kinds, and is so arranged as to require the least possible amount of handling of materials. It is lighted with electric light, on the Mather system, each machine being provided with its own light, so arranged that it can be quickly moved to the point where it is most needed. A number of the universal milling machines are in construction to fill orders, and large machines of this class have recently been sold to the Delaware, Lackawanna & Western, the Union Pacific and the Kansas City, Fort Scott & Memphis shops. Indeed business is so active at present that the firm have been compelled to keep their old shop, using it as a repair shop. A convenient device noticed here was a cast-iron vise bench, having inside a closet with shelves for keeping tools. This bench is heavy enough to seat itself by its own weight, requiring no bolts to hold it in place, and at the same time can be readily moved to any part of the shop.

THE Dickson Manufacturing Company has two shops in Scranton. At the Penn Avenue shops a large amount of work is being done on general machinery, and on the floor of the main shop, which is arranged to take in work of almost any size, there is a great variety of large machinery in process of erection, including two 60-in. cylinders for a blowing engine, and other work of this class. The most striking object, however, is an enormous wheel for the Calumet & Hecla Company, which is probably the largest gear-wheel ever built. This is a sand-wheel, as it is called, intended to pump up tailings from the stamp mills, which cannot be handled with an ordinary pump owing to the large proportion of sand to the water. The wheel is 50 ft. in diameter on the face and 54 ft. outside the teeth, and will carry 448 steel buckets and will have a lifting capacity of 3,000,000 gals. of water and 2,000 tons of sand in 24 hours. The rim of the wheel is made of plates and angle-irons riveted together, and its general construction resembles that of a bicycle wheel, the connection between the rim and the hub being made by steel straining rods 3¼ in. in diameter. There are 18 of these rods and they are all in tension. The teeth are in segments bolted to the rim. The total number of teeth is 432; they are 4.70 in. pitch and 18 in. on the face, and have all been cut by a special machine designed by Mr. Broadbent, Superintendent of the shop. The shaft on which this wheel runs has journals 22 in. in diameter and 40 in. long, and between the journals is 30 in. in diameter. The great wheel will be driven by a pinion having 33 teeth of corresponding pitch and face.

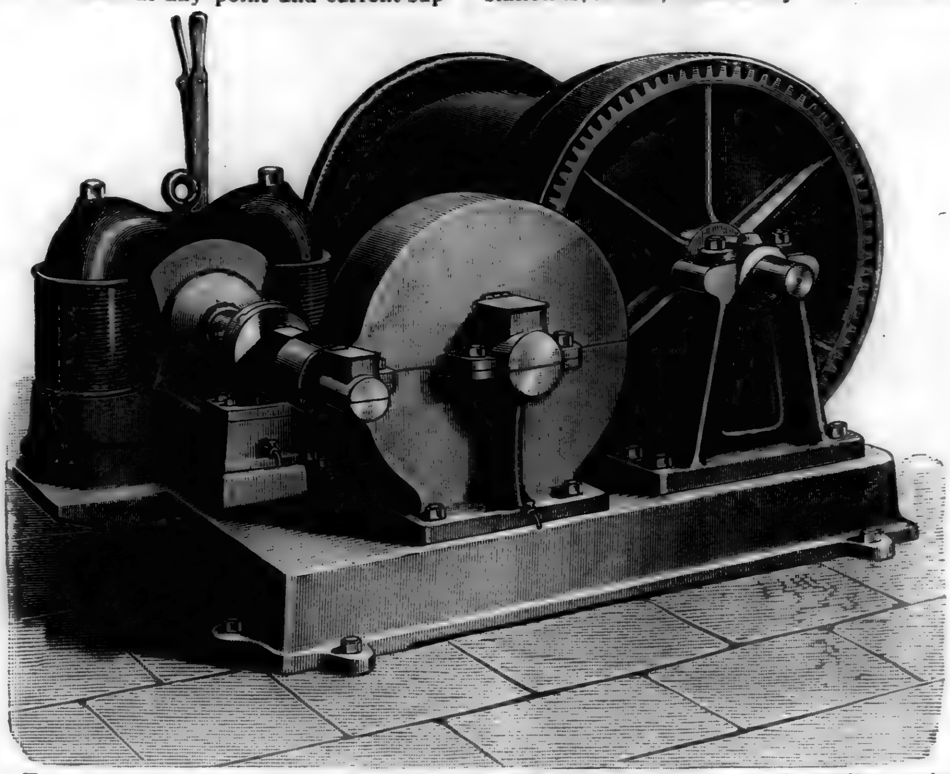
Among other work in the shops are several large cranes for foundry and other purposes. A very neat design for a foundry crane is run by a three-cylinder Brotherhood engine and is not only compact and powerful, but avoids the heavy strain usually thrown upon the turning-post. In the foundry some very large castings have recently been made, including some 90-in. cylinders for marine engines, and a single casting weighing 16 tons for a hydraulic riveting machine.

The other shops of this company, locally known as the Cliff Works, are devoted entirely to the building of locomotives, and are at present very full of work. The orders now on the floor include 15 consolidation engines, with Wootten boilers, for the Delaware & Hudson Canal Company, and five passenger engines, anthracite coal-burners, for the same company. There are also in progress 15 consolidation engines of very large size for the Delaware, Lackawanna & Western Railroad. These engines have 20 × 24 in. cylinders; the boilers are 58 in. in diameter of barrel and have fire-boxes designed for burning culm. The use of this fire-box, indeed, is extending very widely in the coal regions. Those on the engines in question are similar in general design to the Wootten fire-box, but have not the combustion chamber. A noticeable feature of these engines is not only the size of the boilers, but the fact that they are placed very high, the center of the boiler being at a height above the track which would have been considered inadmissible a few years ago.

Work will shortly be begun on a number of mogul engines for the Central Railroad of Georgia, these engines being duplicates of a lot built for the same road last year.

ELECTRICITY has entirely banished animal power on the street railroads in Scranton. The People's Street Railroad Company, which now operates all the lines in the city, was one of the first to try the electric motor, and has been, in operation, one of the most successful. There are in all 25 miles of street railroad in the city and its suburbs, some of which is very difficult to operate, having very sharp curves and grades as high as 10 per cent. The company has altogether 28 cars, 15 fitted with Sprague motors, 13 with the Thomson-Houston, and 3 with the Van de Poele. On these lines the number of passengers carried averages about 175,000 monthly, and on special occasions from 15,000 to 20,000 have been carried in a day. The ordinary duty of a car is about 100 miles per day. The system in use is the overhead wire, the power-wire being carried above the track

on brackets suspended from cross-wires stretched from poles on either side of the street. A feeder-wire is carried on the poles on one side, so that in case of a break in the main wire, a new connection can be made at any point and current sup-



plied without delay. The connection between the power-wire and the car is made by a trolley carried on a long iron rod on top of the car, and the connection can be made or broken by a slight movement of the conductor's or driver's hand. The cars run very smoothly and well, and do not seem to experience any difficulty in climbing the steepest grades.

The power-house, from which power is supplied to the different lines, is very completely fitted up. There are three Armington & Sims engines of 125 H. P. each, which are kept constantly in service, and which run six No. 20 Edison dynamos, having a total power of 600 ampères. A very trying feature in the

work of supplying power is the constant variation in the force expended. The indicators show that this may change abruptly from 10 to as high as 540 ampères, and that the changes are incessant. Steam is supplied to the engines by five tubular boilers 16 ft. long and 6 ft. diameter. There are two furnaces to each boiler, and the fuel used is culm or coal dust, which is supplied from a huge pile at the back of the power-house. The station is, in fact, remarkably well situated for securing a cheap supply of fuel, being in the immediate neighborhood of one of the coal mines with which the region around Scranton abounds. This electric road may be considered in every way a success, and the accidents and delays are fewer in number than on an ordinary horse railroad.

The Sprague Electric Hoist.

THE adoption of electric power in railroad shops and other manufacturing establishments is rapidly increasing, and nearly every day we hear of some new application of this kind for mill and shop purposes. A very short time ago electric motors were a novelty, but now they have been adopted by some of the leading railroads of the country for operating transfer-tables, turn-

tables, traveling cranes, and other machinery where a portable and compact power is required.

The accompanying illustrations show the motor for an electric hoist which has recently been built by the Sprague Electric Railway Motor Company of New York, for railroad shops, mills, and other places where a simple and portable hoist is desired and where a constant potential electric current is obtainable. The machine was built at the Edison Machine Works, Schenectady, N.Y., from designs made by engineers of wide experience in electric work.

The speed of the motor is controlled by an electric switch at one side, by means of which the speed can be varied at will by a single movement of the switch handle. Turning the handle to one notch will make the motor run slowly, to the second notch will increase the speed, and through the full number of notches will run it at full speed, while turning the handle in the opposite direction of rotation. The movements are very simple, so that no expert labor is required, and any one of ordinary engines will quickly become used to the hoist and can handle the switch and operate the motor.

Especial attention has been paid in designing the machine to securing the qualities of durability, compactness, ease of operation, and minimum of wear—qualities valuable in any case, but especially so should it be desired to use this hoist for mining purposes. The illustrations show that no extra room is taken up by the motor, but that everything is arranged to fit closely upon the iron base-frame.

The gears are all boxed in iron cases to protect them from dust, etc., but these cases are so made that they can be quickly removed should it be necessary to reach the working parts.

LARGE DOUBLE-CYLINDER POWER FEED SAND-PAPERING MACHINE.

The motor is designed to give the greatest possible power with the least weight, and has thus been made comparatively light, so that it can easily be carried from one part of the shop to another.

It is claimed that the efficiency of the electric motor when working up to its full load is over 90 per cent.; that is, more than nine-tenths of the energy which is delivered in the form of an electric current at the terminals of the motor is transformed into effective work at the armature pinion. This shows an extraordinary degree of efficiency.

The Sprague Company has completed this design after careful experiments, and it is to be followed by other special applications of electricity for shop purposes.

Manufactures.

Double-cylinder Sand-papering Machine.

THE accompanying illustration represents a machine of unusual size and capacity for putting the final finish on all kinds of wood used in the manufacture of cars, carriages, furniture, etc. As will be seen from the cut, the polishing cylinders are arranged below the bed of the machine; they run in long, self-oiling bearings, and are belted directly from one countershaft. The feeding-rolls are six in number, strongly and expansively geared. Directly above the cylinders there are also two pressure-rolls, which are raised with the upper feed-rolls by a hand-wheel and screw. These pressure-rolls can be adjusted with the feed-rolls, or independently, as may suit the work to be done. They are placed close to the cylinders, giving a positive feed. The polishing cylinders are easily accessible, being placed, as stated above, in the lower part of the frame, while the feed and pressure-rolls are mounted in the upper part. By removing the pintle at the end and turning the hand-wheel, the upper part can be raised to an angle of 45°, giving access to the cylinders for changing the sand-paper, or any other purposes. This arrangement is applied to both ends, so that one end can be raised and then the other, giving free access to both cylinders. Both cylinders have an independent vertical movement to suit the work to be done.

These machines will take any work up to 4 in. thick, and will finish all flat surfaces at one pass through the rollers. They are made in three sizes, 36 in., 42 in., and 48 in. wide. They are built entirely of iron and steel and weigh about 6,000 lbs. A countershaft, with hangers and pulleys, is furnished with each machine. The tight and loose pulleys are 16 × 6 in. and should make 650 revolutions.

This machine is built by the well-known works of J. A. Fay & Company, of Cincinnati.

Manufacturing Notes.

THE Bucyrus Foundry & Manufacturing Company, Bucyrus, O., is very busy, running the works night and day. Last year the company added a number of heavy tools to its plant, built a new erecting shop 180×45 ft. in size for heavy work, and fitted this shop with overhead traveling cranes and all the latest improvements. Its shipments included 48 steam shovels and 16 dredges, many of them very large machines, besides a number of railroad wrecking cars and other machinery. This company has now facilities for turning out a large amount of work.

RECENT contracts made by the Pond Engineering Company, St. Louis, Mo., are for a Holly duplex pump of 100,000 gals. capacity, with boiler, heater, etc., for the water-works at Seward, Neb.; a boiler and engine for the St. Louis Stamping Works; three 50 H. P. boilers completed, with shaking, grates, etc., for Kansas City; a Pond feed-pumping and receiver for the Security Building, Kansas City; a Tracy oil-filter, belting, etc., for the Vine Street Electric Railroad Line. The large pumping engine for the water-works at Taylorville, Ill., which this company is erecting, has been set up and tried. The Pond Company is also putting in the Eastman Hotel, Hot Springs, Ark., one of its largest sized feed-pumps and receivers, and is building a Hoppes live-steam purifier—for keeping boilers free from scale—of 150 H. P. size for Kansas City. Large orders for Sheffield grate-bars are reported.

AN order has recently been placed with W. S. Collins, Licensee, New York, for 72 burners of the Aerated Fuel Company's system, to fit up 36 of the large iron furnaces in the works of the John A. Roebling's Sons' Company, at Trenton, N. J. This order was given after a careful trial of the system. Several other important orders have also been received recently.

THE patents and other property of the Sewall Safety Car-Heating Company and the McElroy Car-Heating Company, together with other patents for car-heating appliances, are now the property of the Consolidated Car-Heating Company, which has been organized with a capital of $2,500,000. The new company, therefore, controls several distinct methods of heating which can be used either separately or in combination. It has established shops and depots in Albany and Chicago, and has its principal office in Albany, with branches in New York and Chicago. The officers of the new company are: President, Robert C. Pruyn; Vice-President, A. S. Hatch; Vice-President and Treasurer, William G. Rice; Secretary, Charles J. Peabody; General Manager, D. D. Sewall; Mechanical Superintendent, J. F. McElroy; Assistant General Manager, J. H. Sewall.

THE grand prize for the best wood-working machinery at the Paris Exposition has been awarded to J. A. Fay & Company, of Cincinnati, O., the well-known American manufacturers of that class of machinery.

THE Erie Car Works, Erie, Pa., are building a Goodwin dump car of the latest improved pattern, dumping either at the side or between the rails, as desired. The car is a four-wheeler, for carrying ore, coke, coal, etc.; it will carry 15 tons of ore in 20 ft. of extended train length. The axles have journals 3¾ × 7 in. in size.

A NEW and extensive deposit of Franklinite iron ore has been discovered in Sussex County, N. J., near Franklin Furnace. It is expected that this deposit will prove as valuable as the original Franklin Mine. The property is owned by the Barnes Iron Bridge & Fence Company, of Philadelphia.

OBITUARY.

CAPTAIN GEORGE SKINNER, who died in Rome, Ga., October 1, aged 60 years, had served as superintendent on the Scioto Valley, the Canada Southern, and other roads. At the time of his death he was Superintendent of the Chattanooga, Rome & Columbus Railroad.

CHARLES A. ANDERSON, who died in New York, October 6, aged 83 years, was born in New York, and in early life was a civil engineer. He located a considerable part of the New York, New Haven & Hartford Railroad and was employed on other important works. Later in life he gave up engineering and became a broker in New York, where he was very successful. Mr. Anderson had considerable literary ability, and for a long time was a contributor to the New York *Evening Post*, and also assisted Mr. Bryant in other literary work.

JOHN CRERAR, who died in Chicago October 19, was widely known among railroad men as the founder and head of the great railroad supply house of Crerar, Adams & Company. He was born in Scotland, but came to this country when a boy, and began life in New York as a clerk, removing later to Chicago. He was largely interested in railroad and other enterprises, and at the time of his death was Vice-President of the Chicago & Alton Railroad Company, a director in the Illinois Steel Company, Pullman's Palace Car Company, and in several banking and other companies. Mr. Crerar leaves a large estate; he was never married.

SIR DANIEL GOOCH, who died in London, England, October 15, aged 73 years, was an eminent engineer. He was born in Northumberland and studied his profession at Newcastle, under Robert Stephenson, and in the large iron works of South Wales. For 27 years he held the position of Chief Locomotive Engineer to the Great Western Railway, and he served as Chairman of the Board of Directors of that company. He was one of the shareholders of the steamship *Great Eastern*. He was elected to Parliament in 1865, and about the same time he became Chairman of the Telegraph Construction & Maintenance Company, and a Director in the Anglo-American Cable Company. The dignity of a Baronet was conferred upon him after the laying of the Atlantic Cable, November 13, 1866. He was a distinguished Mason.

CAPTAIN WILLIAM R. JONES died at his residence in Braddock, Pa., September 26, from the results of an accident caused by the overflowing of a mass of melted metal in one of the furnaces of the Edgar Thomson Steel Works. Captain Jones was born in Luzerne County, Pa., in 1839, and at an early age entered the works of the Crane Iron Company at Catasauqua. He served in the Army during the war, and after its close en-

tered the service of the Cambria Iron Company as Assistant Chief Engineer. Some years later he was appointed Master Mechanic of the Edgar Thomson Steel Works, and later was promoted to be General Superintendent of the works, and held that position until the time of his death. He was considered high authority in the iron and steel business, and devised many improvements which were used in connection with the furnaces of his company. His inventions were a device for operating ladles in Bessemer process, improvements in loose couplings, fastenings for Bessemer converters, washers for ingot molds, hot beds for bending rails, apparatus for compressing ingots while casting ingot molds, cooling roll journals and shafts, feeding appliance for rolling mills, and many others. His latest invention, upon which a patent has not been issued, is a method for mixing metal taken from blast furnaces charging into two receiving tanks. Last year Captain Jones was appointed Consulting Engineer to Carnegie, Phipps & Co. He was a member of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the Engineers' Society of Western Pennsylvania, and the Iron & Steel Institute of Great Britain. He leaves a widow and two children.

PERSONALS.

H. R. TALCOTT has been appointed Chief Engineer of the Seattle, Lake Shore & Eastern Railroad.

A. J. PITKIN, Superintendent of the Schenectady Locomotive Works, has gone to Europe for a brief visit.

J. F. FANNING has been appointed Consulting Engineer of the St. Paul, Minneapolis & Manitoba Railroad.

ALEXANDER LAIRD has been appointed Master Mechanic of the Ohio River Railroad, with office at Parkersburg, W. Va.

C. C. WHEELER is appointed General Superintendent of the Atchison, Topeka & Santa Fé Railroad. He was recently on the Wisconsin Central.

PROFESSOR ARTHUR WINSLOW has been appointed State Geologist of Missouri, and is making arrangements to begin the survey of the city.

K. H. WADE has been appointed General Manager of the California lines of the Atchison, Topeka & Santa Fé. He was formerly on the Wabash Railroad.

FRANCIS COLLINGWOOD is now engaged in examining the Chemung River at Elmira, with a view to devising some plan for protecting the city against floods.

W. G. VAN BUSKIRK has been appointed Master Mechanic of the Terre Haute & Peoria Railroad, with office at Paris, Ill. He was recently on the Cleveland & Marietta Railroad.

GRANT WILKINS has resigned his position as Chief Engineer of the Atlanta Bridge & Axle Works. Mr. Wilkins has been connected with these works ever since they were started.

ANGUS SINCLAIR, Editor of the *National Car & Locomotive Builder*, sailed recently for Europe, where he intends to make some brief observations on the condition of railroad affairs abroad.

A. M. WAITT, recently with the Pullman Car Company, has been appointed Assistant General Master Car-Builder of the Lake Shore & Michigan Southern Railway, with office in Cleveland, O.

ROBERT GORDON, who is well known to many American engineers, has given up his connection with the Burmah Ruby Mining Company and has gone to Siam, where he has undertaken some engineering work.

LIEUTENANT HENRY H. BARROLL, U. S. N., was married at Danbury, Conn., October 3, to Marie Louise, daughter of Mr. T. Granville Hoyt of that place. Lieutenant Barroll is at present in charge of the Hydrographic Office at Norfolk, Va.

COMMODORE FRANCIS M. RAMSAY has been appointed Chief of the Bureau of Navigation in the Navy Department, to succeed REAR-ADMIRAL WALKER, who takes command of the new Squadron of Evolution, composed of the cruisers *Boston*, *Chicago*, *Atlanta*, and *Yorktown*. Commodore Ramsay has been for some time Commandant of the New York Navy-Yard, and it is understood that his successor in that position will be Rear-Admiral D. E. BRAINE.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, September 18, the Secretary announced the death of James H. Morley, a member and late Chief Engineer of the Missouri Pacific Railroad.

Written discussions of the paper on American Bridges read by Mr. Theodore Cooper, were presented by several members.

Mr. Cooper made a brief reply to these discussions.

Mr. H. R. Stanton exhibited a large number of photographs of the Grand Cañon of the Colorado River, where he has recently been engaged in making surveys for a railroad.

At the regular meeting in New York, October 2, a paper on Experiments Relating to Hydraulics of Fire Streams was read by John R. Freeman. It was announced that the ballots on the resolutions presented at the annual meeting had been canvassed, and that these resolutions were adopted. They are as follows:

"*Resolved*, That a committee of three members of this society be appointed by the President, to ascertain the best means of concentrating all obtainable information in such a manner as to secure useful results, and to report to the annual meeting of this society what further action, in their opinion, should be taken in the premises.

"*Resolved*, That a committee be appointed by the Board of Direction to be authorized and instructed to report to the society a set of Standard Rail Sections of weights beginning at 40 lbs., and advancing by increments of 5 lbs. to 100 lbs. per lineal yard.

"*Resolved*, That a committee of seven members of the society be appointed by the President to recommend uniform methods of testing the materials used in metallic structures.

"*Resolved*, That the same committee be requested to report such requirements for these materials as, in their judgment, may conduce to further improve the grade of such structures."

The following candidates were declared elected: *Members:* William A. Aiken, Mt. Vernon, O.; Ward Baldwin, Cincinnati, O.; S. H. Bodfish, Bernard R. Green, Washington, D. C.; Elias B. Noyes, Fort Edward, N. Y.; Charles O. Parker, Macon, Ga.; John C. Patterson, Poughkeepsie, N. Y.; Olaf R. Pihl, Cascade Rocks, Ore.; Anderson H. Tyson, Reading, Pa.; Alva M. Van Auken, Denver, Col.

Juniors: F. Rosenberg, Jersey City, N. J.; William W. Seitzinger, Tarrytown, N. Y.

At the regular meeting, October 16, Professor J. B. Johnson read a paper on Strength of Cast-iron—Tests and Specifications. The paper was long and elaborate, and contained an account of numerous experiments on this subject which the writer had made. The paper was discussed by Mr. Berg and Mr. J. A. Just.

The Board of Direction has received from the Nominating Committee the following list of members selected by the Committee as candidates for officers for the ensuing year. The Committee consists of Messrs. Stevenson Towle, O. E. Michaelis, Frederick H. Smith, Arthur Macy, and J. F. Wallace:

For President, William P. Shinn; for Vice-Presidents, Alphonse Fteley, Mendes Cohen; for Secretary and Librarian, John Bogart; for Treasurer, G. S. Greene, Jr.; for Directors, Charles B. Brush, Theodore Voorhees, Robert Van Buren, William Ludlow, William G. Curtis.

American Institute of Mining Engineers.—The fall meeting was held at Ottawa, Can., beginning October 1. At the evening session addresses of welcome were made by Sir John A. Macdonald and others, and were answered by members of the Association. Several notices of deceased members were read and about 50 new members were elected.

On the second day, the morning was occupied by visits to the great lumber mills in the neighborhood of Ottawa, and to the experimental farm maintained by the Government. In the evening a session was held at which papers were read on Mining and Natural Gas in Canada. In the evening a reception was given to the members by the citizens of Ottawa.

On the third day, the morning was given up to visiting the public buildings. Two business sessions were held at which a number of papers were read relating to Silver, Gold, and Copper Mining in Canada.

This concluded the business portion of the meeting. On the fourth day members went on an excursion to Little Rapids, returning in the evening, and on the fifth and last day the meeting broke up, some members going to Montreal, thence to the As-

bestos Mines in Eastern Quebec, while others went to the Mines at Sudbury.

Western Railway Club.—The first monthly meeting of the season was held in Chicago, September 17. The Secretary reported that the number of members had increased to 180. The following officers were elected for the coming year: President, John Hickey; Vice-Presidents, J. M. Barr and C. A. Schroyer; Treasurer, Allen Cooke; Secretary, W. D. Crosman.

Mr. W. H. Marshall read a carefully considered paper on Exhaust Pipes, Nozzles, and Steam Passages, which was pretty thoroughly discussed by the members present, many differences of opinion being developed in the discussion.

Following this there was a short discussion on Standard Axle-Box and Axle for 60,000-lb. cars.

Resolutions were adopted in favor of holding the Exposition of 1892 in Chicago.

Boston Society of Civil Engineers.—At the regular meeting of September 18, a Committee was appointed to confer with the Committee of the American Society of Civil Engineers on the proposed revision of the Constitution.

A paper on Mills and Mill Engineering was read by Mr. Edward Sawyer which was pretty thoroughly discussed by members and others present.

New England Water-Works Association.—The fall meeting of this Association was made delightful socially by an excursion to the White Mountains. The party included members and their friends, with ladies, and numbered about 60. It left Boston Saturday morning, September 28, took dinner at Plymouth, and got to the Crawford House in the Mountains in time for tea. Sunday was passed here enjoying the famous scenery, with a carriage ride to the summit of Mount Willard for the event of the day, and, indeed, one of the most enjoyable features of the trip. The party went on Monday morning through the great Crawford Notch to North Conway, from which place carriage rides were taken in the vicinity through the forenoon. After dinner the train was taken for Boston, and the party arrived there in the evening.

Connecticut Civil Engineers' & Surveyors' Association.—At the summer meeting in New Haven, there was a large attendance. The Committee on Water-works was requested to procure such records of Rainfall as may be valuable for the use of the Association. The Committee on Rain-gauges reported that 20 self-registering gauges were now in use at different signal stations. It was ordered that a committee be appointed to examine the laws of Connecticut in relation to Dams and Reservoirs and to report what new legislation may be needed.

Papers were read on Earth Dams, by Henry W. Ayres; on Accuracy in Measurements in Ordinary Surveys, by F. W. Whitlock; and on the New Haven Reservoir and Dam, by L. A. Taylor.

After the meeting the members visited the City Engineer's Office and examined the plans of the public buildings and works.

Engineers' Club of Philadelphia.—At the first regular meeting of the season, in Philadelphia, October 5, the Secretary presented a letter from Mr. Conway B. Hunt explaining the postponement, to next meeting, of his paper upon Repairing a Bridge Pier's Foundation.

Mr. George N. Bell presented a paper upon the Development of Suburban Property, in which it is clearly shown that this cannot be done to the best advantage without the assistance of systematic and intelligent engineering and landscape gardening. The paper and kindred subjects were discussed by Professor Arthur Beardsley and Messrs. T. M. Cleeman and Howard Murphy.

Franklin Institute.—The programme of the lecture season for the winter has been issued, and includes a great variety of subjects. Those announced for the present month are: November 4, the Proposed Isthmus Canal Routes, by Admiral Ammen; November 8, Municipal Engineering, by Professor Lewis M. Haupt; November 11, Stereo-Chemistry, by Professor Ira Remsen; November 15, Aeronautics, by Professor W. L. C. Stevens; November 18, Natural History in Schools, by Dr. H. Hensoldt; November 22, Work, Waste and Wages, by Mr. C. H. Clarke; November 25, The Development of Railroad Signaling, by Professor C. H. Koyl; November 29, Canada, by Mr. C. J. Hexamer.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, September 17, the subject for consideration was the appointment of a Committee to meet the Committee of the American Society of Civil Engineers to discuss the proposition made in relation to the co-operation or union of the different engineering societies. This called out a long discussion, in which many members took part, and resulted in the passage of a resolution directing the appointment of such a Committee. The Chairman named as members W. L. Scaife, J. W. Langley, and Thomas P. Roberts.

After this matter had been disposed of, there was a short informal discussion on the impurities in the water of the rivers near Pittsburgh, most of which resulted from the mine water, which is pumped from the mines and runs into the rivers. It was also stated that there are, especially in the Allegheny, many submerged springs, which is probably the case in a great number of rivers.

Engineers' Club of Cincinnati.—At the fourteenth regular meeting of the Club Estus T. Flynn and Charles L. Jungerman were elected to membership.

The subject for discussion was on the cause of and the best means for preventing Creeping of Rails in the Track on Bridges and Viaducts, and was suggested by the trouble being had from that source in the tracks of the Chesapeake & Ohio Railroad bridge at Cincinnati, where the rails are found to be moving from one to three inches per day.

Engineers' Club of St. Louis.—At the regular meeting, October 9, H. M. Kebby was elected a member.

President Meier presented a discussion on a new tractor recently invented by H. L. Van Zile, of Albany, N. Y., which, it was claimed, rendered it possible to make the total power of the machine available for traction. A model of this arrangement had worked very successfully. This was discussed by Messrs. Moore and Gale who spoke of the advantages of such a motor for street railroad work, and also of the similarity in design to the Fell system which had been used in Switzerland.

Mr. C. H. Sharman presented some reminiscences of the construction of the Union Pacific Railroad, in which he took an active part.

Denver Society of Civil Engineers and Architects.—At the regular meeting, October 8, Mr. Jackson, Building Inspector of Denver, read the larger portion of the new ordinance relating to the construction of buildings. The ordinance has now passed the Council and is waiting the passage of the supervisors to become a law. Among the main points covered are the division of the city into two fire districts, one covering the business portion of the city and the other the residence. Parties must defend their foundations to a depth of 10 ft. 6 in. on property lines; foundations for residences must be at least 2 ft. 6 in. deep; 90 days are allowed for the use of one-third of the street in front of property; no business wall in blocks is to end in less than a 13-in. wall; no wooden posts in business blocks over 20 ft. high; all tenement-houses, flats, and stores to be provided with scuttle in roof fastened inside, but not locked. The Society indorsed the ordinance and recommended an additional one regulating the manufacture and quality of brick, as much poor brick is now being used.

General Time Convention.—The fall meeting was held in New York, October 9, 60 roads being represented. The Executive Committee reported that there were in the Association 176 companies operating 120,891 miles of railroad.

The Committee on Car Service was made a Standing Committee, to consist of nine members, to serve for three years, three members to be elected each year. It was decided to appoint a Committee on Safety Appliances, to consider devices for power-brakes, couplers, switches, and signals, and apparatus for heating and lighting cars.

The Committee on Standard Code of Signals reported that during the last half year the Code has been adopted by 15 companies operating 13,135 miles of railroad. There are now 79 companies operating 52,267 miles of railroad which have fully adopted the Code.

The date for the adoption of the Mixed Mileage and Per Diem System of paying for car service, which had been fixed for January 1, 1890, was reconsidered, and the subject will come up for further consideration at the next meeting of the Convention in April.

The Committee on Car Service reported a plan for the organization of Car Service Associations, and also presented forms to be used in conducting the work. This report was approved, but the vote at the spring meeting, which fixed November 1 as

the date for these associations to begin work, was reconsidered and each road was recommended to put the system in operation as soon as possible.

American Society of Railroad Superintendents.—The 18th meeting was held in New York, October 7; 14 new members were elected. The Committee on Headquarters reported that it was not expedient to procure permanent rooms for the Association, believing it best to hold the meetings in different places.

Professor C. H. Koyl read a paper on Signals, describing his new semaphore.

The Committee on Roadway presented a report, the subjects treated in which were Rails and Fastenings, Metal Ties, Signals and Safety Appliances. Several patterns of semaphore signals were referred to, and attention was called to the system of guard-rails for bridges adopted on the Michigan Central. The Committee recommended that the prize offered for the best paper on track-work be awarded to the paper signed "Thistle."

Mr. L. W. Palmer read a paper on Terminal Charges which called out much discussion.

President Gadsden called attention to the merits of the weighted switch lever in use on many Southern roads.

The new Constitution proposed at the last meeting was discussed and finally adopted with some slight amendments. One of these amendments changes the name from the Association of North American Railroad Superintendents to that given above. A Committee was appointed to revise the by-laws and report at the next meeting.

Master Car-Builders' Association.—The Secretary, Mr. John W. Cloud, has issued from his office in Buffalo a circular giving the result of the questions recently submitted to letter-ballot. These questions, with the results of the ballots, are as follows:

1. Journal Box Lid: The Fletcher lid is adopted, but the special form of lid submitted failed to receive the necessary number of votes and is rejected.

2. The form of specification and guarantee for cast-iron car-wheels is adopted, both receiving largely over the required number of votes.

3. The axle for 60,000-lbs. cars, as submitted, is adopted. This axle has a journal $4\frac{1}{4} \times 8$ in. in size, and is 7 ft. $\frac{1}{4}$ in. over all, and 6 ft. 3 in. between centers of journals.

4. Brake-Gear for Air-Brake Cars: The standard, as submitted to ballot, is adopted in all particulars. This standard gives the maximum train-pipe pressure at 70 lbs.; the brake power exerted on all freight cars to be 70 per cent. of their light weight, and the brake beams to be required to stand a stress of 7,500 lbs., with a maximum deflection of $\frac{1}{16}$ in. The present standard brake-shoe to be maintained.

5. Draw-Bars and Carrier Irons for Standard Coupler: The standard submitted under this head was also adopted by a considerable majority. These standards are a draw-bar 30 in. long; draw-bar 28 in. long for repairs; size at neck 5 in. square; carrier-irons $5\frac{1}{2} \times 5\frac{3}{4}$ in.

It may be noted that these standards were accepted by unusually large votes, the number cast being considerable, and the majority given being large in almost all cases and unexpectedly large in the case of the standard axle.

New England Railroad Club.—At the regular meeting in Boston, October 9, the subject for discussion was Permanent Way and Rolling Stock and their Relation to each other. The discussion was opened by Mr. Lauder, who spoke at considerable length, and who was followed by Mr. Ellis, Secretary of the New England Roadmasters' Association, and by Messrs. Bishop, Clarke, Whitney, and others.

It was announced that the subject for the next meeting would be Journals and Journal Bearings.

Western Railway Club.—At the regular meeting in Chicago, October 15, the President read a short paper setting forth the objects of the Club, the advantages already secured, and those to be hoped for.

Mr. D. S. Barnes read a paper on Compound Locomotives, which was discussed by Messrs. Rhodes, Gibbs, Crossman, and others.

Mr. H. D. Sargent presented a paper on Brake-Shoes.

Northwest Railroad Club.—At the regular meeting in Minneapolis, October 5, it was decided to postpone the discussion on Wheels which had been announced for this meeting, until November. Mr. T. A. Griffin, President of the Griffin Wheel & Foundry Company of Chicago, was present, however, and gave a very interesting talk on the Manufacture of Car-Wheels, explaining the different processes adopted and the results obtained. He also spoke at considerable length on the use of contracting chills and on the advantages of balancing wheels.

American Forestry Congress.—The Eighth Annual Meeting began in Philadelphia, October 16, the opening address being made by Hon. Carl Schurz. At the first session a long and interesting paper on Methods of Forestry Reform was read by Mr. Bernard Fernow, Chief of the Forestry Division of the Department of Agriculture. This was followed by a paper on Forestry Legislation in New York, by Doctor H. M. Jarchow, which gave an interesting statement of the methods pursued in that State.

On the third day this paper was discussed by the Congress. Other papers read were one on Economy in Consumption of Timber for Railroads, by Mr. E. E. R. Trataman, and one on Government Forest Reserves in the West, by Mr. E. T. Ensign.

Resolutions were adopted urging upon the Government the establishment of a Commission for the preservation of the forests, on the public lands, and other measures for the encouragement of forestry.

International Marine Conference.—This Conference began its sessions in Washington, October 16, delegations being present from all the principal maritime nations of the world. Admiral Franklin, U. S. N., was chosen to preside over the Conference; Lieutenant Cottman, U. S. N., was chosen Secretary, with Assistant Secretaries from the English, French, and German delegations.

The Conference was expected to continue in session for some time. The programme, which has all been published in our columns, is an extensive one, but it is hardly probable that it will all be acted upon within the time allowed, especially as the instructions of the English Delegates were to confine the discussions as far as possible to marine signals and illustrations on the draft of vessels. The signals, however, were the principal point to be considered.

NOTES AND NEWS.

Making Coal Smokeless.—The *English Mechanic* says: "An invention which should be of considerable importance from a health point of view, was exhibited the other day at Willis's Rooms, St. James's. It consists in the application of some preparation to coal, by which the constituents are said to be concentrated and hardened. In practice the coal is steeped in the solution, and the fuel can be used either wet or dry. Two large fires were shown at the demonstration, one being made with coal in its normal condition, and the other with the treated coal. The difference was manifest, the chemicalized coal giving off but a very trifling amount of smoke, while a good blazing fire was maintained. The treatment of the coal is said to cost 6*d*. per ton, every expense included. The invention is being introduced by the Smoke Abatement & Fuel-Saving Corporation. It is proposed that the coal shall be treated in coal merchants' yards, ready for delivery to the consumer."

Killing by Electricity.—At a recent meeting of the Paris Academy of Sciences a paper by Mr. Edison on the application of electricity in place of hanging as a capital punishment was read. Mr. Edison compared the effects of the continuous currents with those of the alternating currents, and gave the preference to the latter, as he believes that they will cause death without any pain whatever. He described some experiments which he had performed on several of his own workmen. To a question that was put to him, as to what time it would take to consume a body, Mr. Edison replied that the body would not be consumed, but that its temperature would only be raised by three or four degrees, and that the body would then remain as if mummified. Mr. Edison concluded his communication with the expression that death by electricity may be produced instantaneously and without pain. Mr. Edison's paper was referred to the sections of physics and of medicine, and M. Marcel Desprez, the eminent electrician, is to draw up a report on the subject.

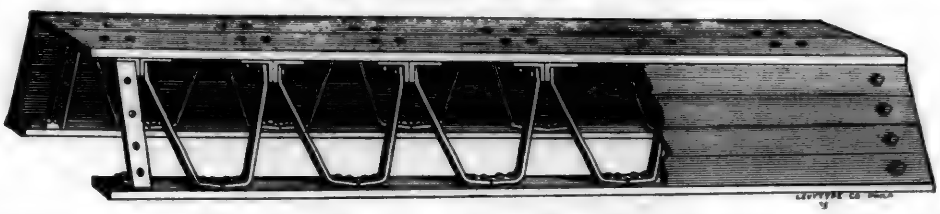
The Indian Survey Department.—A resolution by the Government on the General Report of the Survey Department for the year 1887–88 is issued. It states that the Department was under the direction of Colonel Thuillier throughout the year, and the Report, which presents a record of varied and useful work in survey and exploration, indicates that the De-

partment continues to be maintained in a state of high efficiency. Field operations were prosecuted by 26 parties; and geographical surveys and explorations have been carried out vigorously in Upper Burmah, with the result that triangulation has been extended over an area of 2,300 square miles, while nearly 21,000 square miles have been surveyed and mapped on the ¼-in. scale. The survey officers who accompanied the Hukong Valley and Black Mountain expeditions mapped large areas in comparatively unknown country; and a reconnaissance along the Nepaul border has supplied a rough basis for a more accurate and detailed survey of the northern frontier when opportunity offers. Interesting additional information regarding Bhutan and Thibet has been supplied by native travelers trained by the Survey Department, and new topographical maps, covering 15,673 square miles, have been constructed. The greater part of the available survey force is now devoted to work designed to combine the requirements of revenue administration with the demands of cartography. Taking the cadastral and traverse surveys together, the area covered during the year was upward of 25,000 square miles. The Resolution says that these extensive operations will aid materially in securing a punctual assessment of large tracts of country in which the settlement engagements are about to expire, and the Government of India desires to record its appreciation of the cordiality and zeal with which the Survey Department has lent itself to carrying out the programme imposed upon it by pressing fiscal and administrative considerations in this important section of its duties. The Surveyor-General draws attention to the difficulty of providing officers to superintend the various field operations and the necessity for further recruitment in view of the large number of prospective retirements. These matters are now under the separate consideration of the Government of India.—*The Indian Engineer.*

Testing the Verticality of the Eiffel Tower.—In the erection of the upper portion of the Eiffel Tower, it was found that plumb-lines could not be trusted, owing to the vibration caused by air-currents. It was, therefore, decided to have recourse to the theodolite, and to determine by its aid whether the central lines of the four faces were at all points in the principal planes of the tower. By principal planes is meant the vertical projections along two lines at right angles intersecting in the center of the plan of the tower. On account of the difficulty of marking the central points on the tower, this method of testing its verticality was not found applicable. The difficulty was, however, obviated by sighting to the centers of the faces, points which, as a rule, have a distinctive character, instead of to marked central points. If the theodolite is so placed that when its telescope is rotated, the center of the cross-wires coincides with two points in the horizontal plane of the line of section, the vertical wire will cut the tower in a line following the direction of the principal plane. The testing of the verticality of the tower then consists merely in ascertaining whether the central line of the face absolutely coincides with the determination of the vertical plane. This is a very simple operation, but one susceptible of very great precision. If the observation is made on the four faces of the tower, and the coincidences of the two lines are found to be exact, it necessarily follows that the axis of the tower is absolutely vertical. For the test to be conclusive, the theodolite must, at each observation, be set up with great accuracy in each one of the principal planes. In this manner the verification of the verticality of the tower was actually effected, the results obtained being perfectly satisfactory.—*M. E. Thuasne, in Nouvelles Annales de la Construction.*

Progressive Pressure Trials in Locomotives.—Mr. Dugald Drummond, Locomotive Engineer of the Caledonian Railway Company, is at the present time conducting some very interesting experiments, having for their object the determination of the effect of increasing steam pressures on locomotive economy. As is well known, Mr. Drummond believes that a non-compounded locomotive engine, working at the same pressure as a compound, is more economical than the compound engine, and the experiments now in progress are to thoroughly test economy by progressive pressures. For two or three weeks past he has been running an engine under steam of greater pressure than the standard, taking indicator cards and other data of the working, and the results obtained have induced him to make a series of progressive pressure trials to investigate the whole subject. He has secured six recently constructed non-compound locomotives of the ordinary type. In all respects they are alike, and they are driven by thoroughly capable men. These engines he purposes putting on the Carlisle and Aberdeen trains, a route favorable for such experiments, as the speeds are variable, the maximum being over 60 miles an hour; and the total distance is 249 miles. The only respect in which they will differ the one from the other will be in the working pressure. Two of them will be worked at 150 lbs. per square inch, two others to 175 lbs., and the remaining pair to 200 lbs. The advantage of duplication is obvious. Not only will cards be taken, but the coal consumption will be carefully noted, as well as revolutions, speed, and every other matter of interest, with grades, loads, and atmospheric conditions. The results of these trials will be of high interest and value.—*London Engineering.*

A New Iron Culvert.—The accompanying illustrations show a new design for an iron culvert for railroad and highway bridges which presents many advantages, as will readily be seen. Its construction will be easily understood from the engravings.



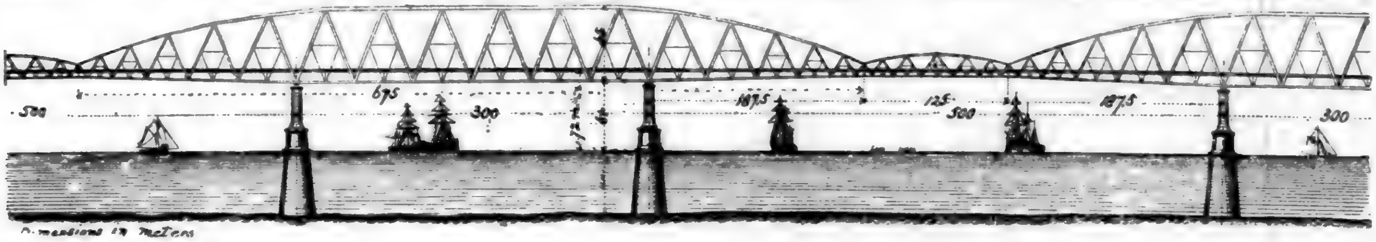
The foundation consists of two wrought-iron sills the same length as the culvert, which form the base pieces upon which rest the girders or trusses, which rise to the desired height. To these trusses the planks or iron sheets forming the top and side-coverings are fastened. The girders are arranged in pairs inclining toward each other, the top horizontal portions being fastened together; at the bottom they are securely bolted or riveted to the sills. The top for highway culverts is generally covered with plank, but for railroad culverts where there would be some depth of earth over the culvert, iron would be used; the sides may be covered with iron or plank as preferred, but iron sides are considered the best.

In putting the culvert in, trenches are dug on each side of the stream, in the same way as for the first course of a stone foundation, to a depth a little below the bed of the stream, and sufficient to secure a solid foundation for the sill pieces to rest upon.

The iron sills are then set right down in the trenches, the earth filled in and rammed down well so as to make it solid like the rest of the road, and the bridge is then ready for use. The top may be on a level with the adjacent roadway, or may be placed below the level and covered over with the same kind of earth or dressing as forms the road-bed, according to the location.

The designers of this culvert claim that it is not only cheap, strong, and durable, but in case of heavy freshets, it is not likely to be destroyed, and even if the bank should be washed out entirely, the culvert will hold together and can be readily replaced. It is manufactured by the Barnes Iron Bridge & Fence Company, of Philadelphia.

Bridging the English Channel.—The French and English technical papers have been discussing for some time a plan proposed by M. Hersent and by MM. Schneider & Company, the owners of the great iron works at Creusot. This plan is for a



bridge to cross the English Channel and to carry a line of railroad from the English coast to that of France. At present it is, perhaps, unnecessary to discuss too closely the details of this scheme, and it may be sufficient to say briefly that it is proposed to found the piers on caissons sunk to the bottom of the Channel, which, it is said, does not present anywhere any serious obstacles to a proper foundation. The main difficulty will be not in finding a solid bottom, but in placing the caissons and beginning the masonry on account of the roughness of the sea. When once the masonry is above the water level, it is claimed that no serious difficulties will be presented.

The proposed bridge is to have a clear headway of 61 m. (200 ft.) above low-water mark, which will prevent interference with navigation. The track level will be 72 m. (236 ft.) above the water-level. The general plan for the arrangement of the superstructure is outlined in the accompanying sketch. The piers will be placed alternately 300 m. (984 ft.) and 500 m. (1,640 ft.) apart; the superstructure will be of the cantilever type, consisting of spans 675 m. (2,214 ft.) in length, resting upon the piers, which are placed 300 m. apart. The openings of 500 m. will be covered by the projecting portions, 187.5 m. (615 ft.) each, of the two cantilever spans and by a short span 125 m. (410 ft.) in length, connecting the two. The extreme depth of the trusses of the long span will be 65 m. (213 ft.). These dimensions may, of course, be somewhat altered, should the plan be actually carried out. The two trusses are to be inclined somewhat to the horizontal and are to be connected by a suitable system of cross-bracing.

The floor of the bridge is to consist of two lines of rails supported by four rows of longitudinal beams, which will be carried on a suitable system of cross-girders resting upon the lower chords of the bridge trusses. A foot-walk will be arranged on either side outside of the rails.

Whether this plan will be carried out is very uncertain. That it, or something resembling it, is feasible, does not seem to be doubted, and while the details are open to discussion and the general plan to amendments, the main objections brought up so far have been the cost of the work and the possible objections of a political and international kind, similar to those raised to the building of the Channel Tunnel. As the estimated cost of the proposed bridge is $170,000,000 there may well be some doubt as to whether it would be a profitable investment.

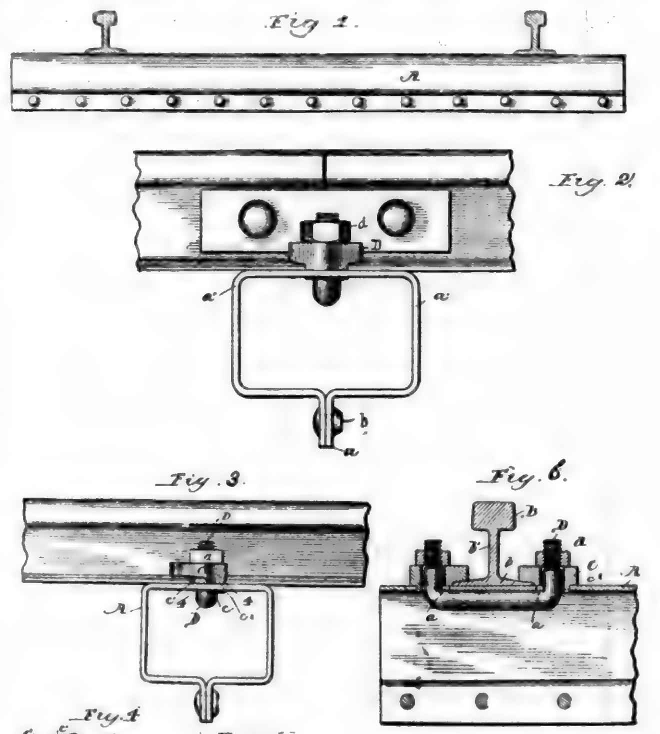
Foreign Gun-Notes.—Considerable dissatisfaction has been felt in Belgium for some time because orders for guns were sent to the Krupp Works in Germany. This feeling was so strongly expressed that the Government finally consented to test the ability of the Cockerill Company, whose bids had been rejected. Careful comparative tests of the material offered were made, and the final result was that the specimens submitted were declared superior to those from Krupp, and an order was given to the Cockerill Company for 62 guns of 12 cm. caliber.

The smokeless gunpowder which has been provisionally adopted for the German Army was tried in the recent fall manœuver with great success, and it is stated that the officers of the German General Staff are now willing to concede all the advantages claimed for it by the inventor. This smokeless powder, which was invented by an Austrian chemist, Dr. Falkenstein, was originally offered to the Austrian War Department and not approved.

Speed of Vessels in a Canal.—French naval engineers have been discussing the reduction in speed caused when the ship passes through a canal or narrow channel, and also the additional power required to move vessels in such a channel. Estimates of the reduction varied from one-half to one-third when based on theoretical calculations. Experiments actually carried on in the Suez Canal at points where the cross-section of the canal was about 4½ times the area of the immersed midship section of the steamer, show with the same number of revolutions of the screw, a reduction of about 54 per cent. in the speed of the vessel. Some further careful experiments were made with a model of the Corinth Canal in order to ascertain the resistance in this canal, the banks of which will be in many places nearly vertical. In this case it was found that with the same power, the reduction in speed would be from 46 to 58 per cent. from that made in the open sea.

A New Metallic Tie.—The accompanying illustrations show a new form proposed for metallic ties for railroads. Fig. 1 is a side elevation and fig. 2 an end view of the tie and rail; figs. 3, 4, 5, and 6 show the clamp or fastening which it is proposed to use with this tie. The body *A* of the tie is formed from a single plate of steel of suitable thickness, bent so as to form a hollow four-sided box, with the edges of the plate flanged outward at *a*, so as to receive the rivets *b*. These flanges *a* are arranged at the under side in order that they may be firmly imbedded in the ballast, so as to prevent any lateral movement. The corners are rounded or beveled as at *a'*, so as to give greater elasticity of action.

The clamp, as shown in figs. 3, 4, 5, and 6, consists of a U-shaped bolt provided with nuts *d d*. These nuts are screwed down on the jam-blocks *C C*, which are formed with a shoulder or off-



set, which when they are in position projects over the foot of the rail, while they are prevented from turning by the projection on the under side which fits into the hollow in the tie through which the ends of the bolt *D* pass. As will be seen from the illustrations, if the jam-blocks are turned in their proper position by a suitable wrench, the shoulders or off-sets *c c*, figs. 4 and 5, will bear against the rear edges of the holes in the tie, while the shoulders or extensions will bear upon the edges of the rail flange *b*. At the same time the upper part or body *C* of the jam-block will overlap the rail flange, and if the nuts *d d* be screwed down, the several parts will be securely held in position and the rail clamp firmly to the tie.

This tie is covered by Patent No. 411,959, and the clamp by Patent No. 411,958, both issued to Mr. Robert Forsyth, of Chicago, under date of October 1 last.

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THE present number of the RAILROAD AND ENGINEERING JOURNAL contains the beginning of a series of articles under the general heading of "Contributions to Practical Railroad Information." The first of them, and some of the succeeding ones, will be on the subject of Chemistry Applied to Railroads, by C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad. These are contributed with the permission of Mr. Theodore N. Ely, Superintendent of Motive Power of that line, and, as their title implies, will give an account of the uses to which chemistry has been applied in the operation of a great system of railroads. The purpose of the articles will be to give plain accounts of knowledge gained by actual experience and practice on railroads, and show the advantages which have resulted from the application of the science of chemistry to the testing of materials, and to other departments of railroad operation.

It is intended that this first series of articles shall be succeeded by others on various subjects connected with railroad engineering, on which more or less definite information has been obtained on the Pennsylvania and other lines of railroad during the past 15 years.

THE Engineering Department of the Iowa State University has undertaken to make a series of tests of cements of various kinds. The tests and experiments will extend through the entire year, and will be conducted according to the methods suggested by the American Society of Civil Engineers. Great care will be exercised, and as the University is provided with the best apparatus for this purpose, the results cannot fail to be valuable. The testing machines and the whole outfit of the Cement Laboratory are new, having been recently furnished to the University by the firm of Riehle Brothers, of Philadelphia. Manufacturers can assist materially in these tests by furnishing samples of their cement, the freight charges on which will be paid by the University, but none will be omitted, as where samples are not furnished they will be purchased in the open market. The results of the tests will be published when they are completed.

IN an article given on another page, Dr. Roll, a distinguished Austrian authority, criticises somewhat severely the organization of the International Railroad Congress. Some of the defects which he mentions are, perhaps, inherent in the nature of such a body, but to those who have followed its proceedings since the first meeting, it must be apparent that others of his criticisms are not unjust. The conclusions reached by the Congress at the Paris meeting must, however, be of interest to railroad men everywhere, as the expressions of opinion given out by a body largely composed of men of long training and experience in their profession. That some of the conclusions are indefinite, and others evidently the result of a compromise, will not be disappointing to those who know anything of the nature and proceedings of similar associations here. The Congress attempts to cover a very extensive field and to dispose of a wide range of questions, the consideration of which, in this country, is divided up among a number of technical societies. It must be remembered also that it suffers from one trouble which equally affects our Conventions—the absence of any authority to enforce its decisions or to require their adoption by the several railroad managements, whether stated or private. Whatever its decisions may be, they are not binding, but only advisory in their nature, and the extent to which they are respected depends upon the individual managements.

One complaint made has a very familiar sound here—it is that the railroads do not, as a rule, take pains to answer the circulars of inquiry on different topics which are sent to them by the Executive Commission of the Congress. There are notable exceptions, it is true, but the neglect is general enough to make the results of the investigations conducted between the meetings far less satisfactory than they should be. On several points where it is desirable that experience all over Europe under widely varying conditions of climate, traffic, etc., should be collected, the results actually

given are from one or two countries—sometimes from one or two roads—only.

With all of these drawbacks, however, the results obtained so far—the Paris meeting was the third since the organization of the Congress—have been very good, and the papers and reports prepared have included a great deal which is valuable to railroad men everywhere.

The only delegate from the United States who took part in the last meeting of the Congress was Mr. Ely, of the Pennsylvania Railroad, who joined in the report on Question XIII.—On the Dead Weight of Trains.

THERE are to be next year some competitive trials between English and American locomotives, provided American builders respond to the invitation which has been sent them to take part in the Edinburgh Exposition. The managers of that Exposition have asked a number of the locomotive builders of the United States to send representative passenger and freight engines of American types for that purpose, and should they be sent, the trials will take place on some of the Scotch railroads. It is not very probable, however, that much will be done in this way, for while our American builders have no reason to fear the results of such a contest, the expense of sending a locomotive to Scotland will be very great, and the prospect of any material return very small. The same reasons which prevented any large representation of this department of our manufactures at Paris will operate still more strongly against a local exposition like that at Edinburgh.

FROM arrangements recently completed, which include the consolidation of two of the Swiss Railroad companies, and a contract made by them with several German banks, it appears probable that work will soon be begun upon the great Simplon Tunnel, which will be the fourth tunnel under the Alps, and the longest tunnel in the world. From the surveys for this tunnel, which were made some years ago, the length has been determined at 19,795 m. (12.30 miles), and in addition to this there will be a connection about 1¼ miles in length from the northern end of the tunnel to Brieg, where the connection with the Swiss railroads will be made. The grade in the tunnel will run both ways from the summit near the center, having a fall of 1:500 going northward to Brieg, and of 1:125 going southward to the Italian end at Iselle.

The cost of this tunnel is estimated by the engineers at a little less than 4,000 francs per running meter, which would bring it up to about $16,000,000. Adding to this the cost of the short line north of the tunnel, the interest on the capital employed during construction, and making allowance for unexpected difficulties which may be encountered, it is thought that about $18,000,000 will be required. A portion of this capital will be supplied by subsidies from some of the Swiss cantons, from the Italian Government and from the cities of Milan and Genoa; the remainder will be furnished by the Swiss companies. It is expected that between seven and eight years will be required for the excavation of the tunnel.

A REPORT has recently been made by the Commission of Engineers appointed to consider the plan for connecting the city of Paris with the sea by a ship canal. The report is strongly in favor of the work, and says that the engineering difficulties to be encountered are not great, while the advantages to be obtained will fully warrant the expenditure required, which is estimated at $40,000,000. The canal would be 180 km. (112 miles) long, and would have a depth of 6.2 m. (20.34 ft.). The material excavated could, it is said, be advantageously used in raising the levels of the lowlands adjoining the lower Seine.

THE Girard Hydraulic Railroad, which attracted so much attention at the Paris Exposition, is to have a practical trial in England under the direction of Sir Edward Watkin. An experimental line of two miles in length will be built near London, and a thorough test made of the invention under conditions as near those of practical working as possible.

FOR some time past there have been very contradictory advices in relation to the Chinese railroads. Nearly a year ago the proposed extension of the Tien-Tsin Line—the only railroad in China—was stopped after work had been actually begun upon it. In September last, a new start was taken, and it was stated that the construction of a very important trunk line, extending from Pekin across the country to Hankow, a distance of about 700 miles, was ordered, and the necessary surveys were begun. The latest news, however, announces that the party which is opposed to the introduction of railroads and other foreign inventions has succeeded in carrying its point, and that the building of this road had been indefinitely postponed. What the result will be it is impossible to say; but there is no doubt that the progressive party, headed by the Viceroy Li-Hung-Chang, will use every effort to secure the execution of the first decree and the building of the road. Any innovation in China has to encounter such an enormous opposition from the rooted political and social prejudices of the people that the introduction of railroads is no easy task.

FOR the year ending with September last the traffic of the Manhattan Elevated lines in New York shows a lower percentage of increase than for some years past, the figures being as follows, including all the lines, for four years:

	1885–86.	1886–87.	1887–88.	1888–89.
Passengers....	115,109.591	158,963,232	171,529,789	179.497,433
Increase over previous year.	11,754,862	42,853,641	12,566,557	7,967,644
Per cent. of increase.......	11.4	37.2	7.9	4.6

The increase in 1886-87 was the largest in any one year since the opening of the roads, and was due to a variety of causes; it is not probable that such an extraordinary gain will be shown in one year hereafter, unless under exceptional circumstances—the holding of the International Exposition in the city, for instance.

It may be of interest to compare the traffic of the several lines for three years past, as is done in the following table, in which the first column under each year shows the number of passengers carried on each line, the second the percentage of the total number credited to that line:

	1886-87.		1887-88.		1888-89.	
Lines.	Number.	Pr. ct.	Number.	Pr. ct.	Number.	Pr. ct.
Ninth Ave....	16,650,707	10 5	17,814,411	10.4	18,131,368	10.1
Sixth Ave.....	45,204,992	28.3	53.115,965	31.0	58,329,410	32.5
Third Ave.....	66,575,454	41.9	68,308,460	39.8	69,924,730	39.0
Second Ave....	30,532 079	19.3	32,290,953	18.8	33.111,925	18.4
Total	158 963,232	100.0	171,529,789	100.0	179,497,433	100.0

Thus the percentage of the total traffic carried by the West-side lines—Sixth and Ninth avenues—for the three years respectively, has been 38.8, 41.4, and 42.6, while

that going over the East-side lines—Third and Second avenues—has been 61.2, 58.6, and 57.4. The East-side lines still continue to carry the larger number of passengers, and have not only held their own in actual numbers, but show a small and pretty steady gain; but the main increase has been on the West-side lines. This is not surprising to any one who has watched the growth of the city and has seen how much the tendency of population has been to the West side. This has been in a measure necessary, for the East side of the city was in great part built up years ago, and on the West side, up-town, were the only considerable tracts of land open for building. This is still the case, and a further development of traffic in that direction is to be expected.

ONE thing is evident to all who have any acquaintance with the city travel; the present lines have very nearly reached the limit of their capacity. They are already unable to accommodate the ordinary travel properly, in spite of careful and efficient management, and any considerable increase must cause trouble. No great addition to their capacity is possible, and the building of new lines of some kind is a necessity, if the city is to continue to grow. What they are to be is, at present, very uncertain; there are plenty of projects, but very little prospect that any of them can overcome the opposition of rival interests.

THE International Marine Conference has continued its sessions in Washington during the month, and the members have worked hard at the long and important programme of subjects submitted for their discussion. At the present writing the work has not yet been concluded, but a substantial agreement has been reached on the rules establishing a general code of signals and the rules of the road at sea. The work has so far been well done and will have excellent results. It will take some time to secure general approval of the action of the Conference, but the probability is that it will be accepted in the end by all the leading maritime nations.

THE new cruiser *Baltimore* passed through her second trial very successfully, proving herself, as on the first trial, to be a very fast boat. The full official details of the trial have not been published as yet, but it is stated that the average speed for the four hours' run was 20.1 knots per hour, or somewhat in excess of the average of the former trial. The *Baltimore* has thus proved herself to be one of the fastest war-vessels in the world. There is no doubt that she will be accepted, and the probability is that the official figures will show that the full power required by the contract has been developed.

PLANS have been completed and bids called for for the construction of four more vessels, which have been authorized by Congress. These are the Thomas submerging cruiser; two 1,000-ton cruisers—Nos. 11 and 12—and the practice cruiser for the Naval Academy. The Thomas cruiser is to be a vessel of the *Monitor* type. It was described and illustrated in the JOURNAL for February and March last.

The two 1,000-ton cruisers are to be small vessels carrying a powerful armament for their size. The general dimensions are: Length, 190 ft.; breadth, 32 ft.; mean draft, 12 ft.; displacement, 1,050 tons. They are to carry two masts, with fore-and-aft rig, and will be able to make a considerable spread of canvas. The engines will be of the triple-expansion type, capable of working up to 1,600 H.P., and the maximum speed is to be 14 knots an hour. These ships will carry a main battery of eight 4-in. rapid-fire guns and a secondary battery of four revolving cannon, one small rapid-fire and one Gatling gun.

The practice cruiser has been designed with the idea of including complete facilities for practical instruction in seamanship, steam engineering, ordnance, and torpedo service. Its dimensions will be as follows: Length, 180 ft.; breadth, 32 ft.; mean draft, 11½ ft.; displacement, 835 tons. The vessel will carry three masts. The engines will be capable of working up to 1,300 H.P., and the maximum speed will be about 13 knots. At a low speed—eight knots—the ship will have a cruising range of 3,850 knots, with her normal coal supply. The armament will consist of four 4-in. rapid-fire guns as a main battery, five small rapid-fire guns, one revolving cannon, and one Gatling gun as a secondary battery, and it will also be provided with torpedo equipment.

A THANKSGIVING SERMON ON ETHICS AND RAILROAD SUPPLIES: BY A LAYMAN.

ON Thanksgiving Day it is not unusual for preachers to feel that the restraints of their sacred calling are temporarily loosened, and that they are then at liberty to discuss some secular subject in their annual sermons. It is, perhaps, quite as natural that such occasions should lead persons whose lives are devoted to secularity to serious reflections, as it is that those whose duty it is to be solemn should then feel buoyant. If on the day set apart for cultivating and expressing the feeling of gratitude clergymen wander from their own special precincts—in which no one is authorized to speak but themselves—into other fields, where only editors assume infallibility, the former can hardly demur if at the same time one of us should assume the privilege of discussing moral and ethical subjects, and, as it were, "exchange pulpits" with them.

Traditional gossip also bears witness to the practice among the clergy of periodically inverting their barrel of old sermons. Frankly be it admitted, then, that in this, too, we are imitating the example of our clerical brethren. We have turned the receptacle of old editorials upside down, and, lo and behold! among them is a sermon which was preached years ago, from another pulpit, it is true, but, doubtless its precepts were instilled into some of those who will form part of the congregation at our imaginary service this year. Be it understood, then, that this is the same old sermon, but thoroughly revised to "suit the times," and with a new text, which is from Job 17:9: *The righteous also shall hold on his way, and he that hath clean hands shall be stronger and stronger.*

Following the method of the preachers, we will begin by ignoring our text entirely, and commence with an interrogative:

Firstly. What is Ethics? Going to the dictionary for an answer, we find that it tells us, among other things, that it is the "science of human duty," and "rules of practice in respect to a single class of human actions." Going back, then, to the subject of our sermon, and we may para-

phrase it into Rules of Practice in Respect to the Purchase of Railroad Supplies. This amplification of our subject leads us to

Secondly. What are the rules of practice in respect to the purchase of railroad supplies? Much might be said or written on this branch of our subject. A conscientious novice who undertakes to sell materials or equipment to railroad companies will find that there is a great deal to be learned of human nature in that department of human action. A little experience will very soon lead him, like David—or whoever wrote Psalm 116—to say in his haste, "All men are liars." This, as the author of the quotation intimated, will be a hasty conclusion, and to some extent untrue. The natural supposition of a conscientious man would be that those intrusted with the duty of procuring supplies for a railroad would be concerned, first of all, and entirely, in getting such articles as would be of the greatest service to the companies whose interests they represent. Now, while this is so in *most* cases, there are many in which quite different motives have an influence in the selection of what is bought and supplied to the companies.

Now, what are these motives? To avoid misapprehension, it will be well to begin by saying that on many railroads those intrusted with the duty of selecting and determining where and what equipment and supplies shall be bought, are as scrupulous, as conscientious, as honorable, as just, as sagacious, and intelligent as any class of business men in the community. On other roads the condition of things is somewhat otherwise. Personal favoritism and the cupidity of those who are intrusted with this duty influence their decisions and actions to a greater or lesser extent. To speak plainly, it is generally believed that on many roads the selection and purchase of materials is influenced by some form of bribery. This brings us to

Thirdly. What is bribery? It has been defined "as the administration of a consideration or reward, that it *may be* a motive in the performance of functions for which the proper motive ought to be a conscientious sense of duty."

There is an impression in the minds of some persons that bribery is a modern vice. The Scriptures give abundant evidence that it existed in ancient times, and that its influence was almost as well understood in those days as it is now. Thus in Proverbs we read:

> The king by judgment establisheth the land; but he that receiveth gifts overthroweth it.—*Proverbs* 29 : 4.

When Samuel in his old age challenges a rigid scrutiny of his conduct, he says:

> I am old and gray-headed; and, behold, my sons are with you: and I have walked before you from my childhood unto this day. Behold, here I am: witness against me, . . . whom have I defrauded, whom have I oppressed? or of whose hand have I received any bribe to blind mine eyes therewith?—1 *Samuel* 12 : 1–3.

Again, it is said:

> And it came to pass, when Samuel was old, that he made his sons judges in Israel. . . . And his sons walked not in his ways, but turned aside after lucre, and took bribes, and perverted judgment.—1 *Samuel* 8 : 1–3.

And Amos, when denouncing the condition of the Israelites under Jeroboam, says:

> Ye have built houses of hewn stone, but ye shall not dwell in them; ye have planted pleasant vineyards, but ye shall not drink wine of them. For I know your manifold transgressions and your mighty sins: they afflict the just, they take a *bribe* (or *ransom*), and they turn aside the poor in the gate from their right.—*Amos* 5 : 11, 12.

The reference to those who "have built houses of hewn stone" sounds as though Amos had some modern railroad men in mind.

The condemnation of the author of Psalm 31 is also emphatic. He says:

> Judge me, O LORD; for I have walked in mine integrity: . . . Gather not my soul with sinners, nor my life with bloody men; in whose hands is mischief, and their right hand is full of bribes. —*Psalms* 26 : 1–10.

Neither is it possible to mistake Job's opinion of bribery. There are railroad men who would probably do well to either reform some of their practices or else not read what Job says, or perhaps better still, read and then reform. He exclaims:

> For the congregation of hypocrites shall be desolate, and fire shall consume the tabernacles of bribery. They conceive mischief, and bring forth vanity, and their belly prepareth deceit. —*Job* 15 : 34, 35.

The case of Lord Bacon stands out most prominently as an example in history, as the one which made the acceptance of bribes by judges infamous. He was accused, and finally confessed to receiving bribes while acting as Lord Chancellor on 28 different occasions. He palliated nearly all of those by the fact that the considerations were received *after* his decisions had been made, and affirmed that he never "had bribe or reward in his eye or thought when he pronounced any sentence or order," and it is said by one of his biographers that "so far as any of these cases can be traced, his decisions, often being in conjunction with some other official, are to all appearances thoroughly just."

Notwithstanding these extenuating circumstances, he was found guilty, and sentenced "to undergo a fine and ransom of £40,000; that he should be imprisoned in the tower during the King's pleasure; that he should be forever incapable of any office, place, or employment in the State or commonwealth; that he should never sit in parliament, or come within the verge of the court." This decision, his historian * says, "had a great constitutional value; it inflicted upon an abuse which had been heretofore tolerated a punishment which made it thereafter infamous. All questionable transactions between judges and suitors were from that day at an end in England."

Bacon made the plea that his intentions had always been pure, and had never been affected by the presents he received. His justification has been set aside by modern critics, not on the ground that the evidence demonstrates its falsity, but because it is inconceivable or unnatural that any man should receive a present from another, and not suffer his judgment to be swayed thereby.† This suggests

Fourthly. Why is it wrong to take bribes, and when is it culpable to receive gifts?

A great many persons who accept bribes excuse themselves, as Bacon did, with the plea that their intentions and judgments are not swayed by the presents they receive. It may be inferred that such persons have never analyzed very scrupulously the "processes of voluntary action, as well as the emotional states that precede and prompt to it," and do not realize how delicate that quality of disposition is which must be exercised when we sit in judgment

* See "An Account of the Life and Times of Francis Bacon," extracted from the edition of his occasional writings, by James Spedding. Houghton, Osgood & Company, Boston.

† See article on Francis Bacon in the Encyclopædia Britannica.

on matters where it is difficult to discern right from wrong, or truth from error. As a writer on ethics says, "It is held that a certain state of the agent's mind, a certain quality of disposition, motive, intention, or purpose is essential to the perfect moral goodness of an action." Now, what shall be thought of a person who occupies a position of responsibility, and to whom is confided a trust, and who is paid to be loyal to the interests of those who employ him, and who yet allows the sordid motive of private gain to be interposed between him and his duty. If the strongest trees incline in the direction of prevailing winds, how much more likely that a plant as delicate as the human conscience will yield under the influence of a greed for gain. Righteousness, or the quality of being right, just, equitable, and impartial, will wither in the atmosphere of human covetousness. He who accepts a bribe poisons the very motives of rectitude, and admits the virus of iniquity into the sacred temple of his own honor.

The old biblical writers understood this. Solomon said that a king who received gifts "overthroweth the land." With equal force it might be written to-day that a manager of a railroad who receives gifts "overthroweth it," and a good many of them have done so. Samuel protested that *his eyes had not been blinded* by receiving any bribes, and it is said that his sons who succeeded him "turned aside after lucre, and took bribes and perverted judgment." It is as true to-day as it was thousands of years ago, that the effect of bribes now is *to blind men's eyes* and *pervert judgment*, and there are railroad men to-day who, if not blinded, have certainly been made mentally and morally cross-eyed by receiving gifts.

David speaks of these as "bloody men, in whose hands is mischief." It could be said to-day of a certain class of men on railroads and elsewhere whose "right hands are full of bribes," that they are "bloody men in whose hands is mischief." It is often the duty of such men to be the judges of the efficiency of certain appliances for the safety of those who travel, and more than all, those who are employed on railroads. No condemnation can be too severe on men in such positions whose judgments are perverted by turning aside after lucre. Think of the responsibility of a person who has deliberately defiled the highest faculty of a human being, that of free will, and it may be has thereby caused human life to be sacrificed and been responsible for untold suffering.

The insidious way in which bribery is practised often makes it difficult for those who have not much mental acuteness to recognize the enormity of it. Playing cards and letting the person to be bought win is an old practice. Another is to begin by giving small gifts, and gradually increasing the value of the bribes. The receiver does not discover until it is too late, and he is in the power of the giver, that he is on dangerous ground. An instance is related of a manufacturer who was obliged to send an agent to erect and put his machines to work at an expense of $100. The Master Mechanic was informed that it was his duty to erect and put the machines to work, and that if he would do so the manufacturer would thereby be saved the expense of sending an agent to do the work; and that if he would attend to the business for them, that they would pay him the $100 instead of paying it to an agent. This all looks very fair, and unless a person in the position of the Master Mechanic has considerable capacity to discover nice moral distinctions, he would not see wherein it was wrong for him to receive the money. It was, nevertheless, as much a bribe as though it were not disguised so ingeniously, because it was "the administration of a reward that it might be a motive in the performance of functions for which the proper motive ought to be a conscientious sense of duty."

To describe the various methods which are adopted in order to make it appear that the receiving of gifts is *not* bribery, would take a long article to describe. They are administered under the guise of disinterested friendship. The wives and daughters, and the sisters, the cousins and the aunts of the persons to be influenced are sometimes the recipients of the benefits. The sacrificial Thanksgiving turkey has no doubt done service in this capacity full many a time and oft.

The evil is not confined to any class. Charges of such infidelity are made against persons in the highest as well as the lowest positions. Our own craft is not blameless. The influence of free passes in blinding editorial eyes and perverting journalistic judgment would furnish material for a whole sermon.

Another insidious form that bribery takes is that of advertising schemes like maps, catalogues, etc., which are issued by and are a source of profit to the subordinate officers of railroads. They send letters to and personally solicit advertisements from those who sell material or equipment to their companies. The manufacturers or dealers are afraid to refuse, for fear of losing the business, which in many cases the solicitors can influence. This is worse than a bribe, because it is *soliciting* a consideration, which may be a motive in the performance of functions for which the proper motive ought to be a conscientious sense of duty. It is, in fact, a form of extortion. If persons who can influence or control the purchase of railroad supplies palliate such practices, as Bacon did, by saying that they have not the profit of advertisements in their eye or thought when the purchase of supplies is under consideration, most persons will feel inclined to put their tongues in their cheeks and pass by on the other side. The higher authorities on railroads should peremptorily suppress this practice, which requires a harsh name to designate it properly.

Another incentive to unfaithfulness to the trust which most railroad officers hold is the owning stock or holding interests in companies or firms engaged in the manufacture or the sale of equipment, supplies, or material, on which such officers must sit in judgment. In cases of this kind they receive a reward from the profits of such companies or firms, which "may be a motive in the performance of functions for which the proper motive ought to be a conscientious sense of duty," and it thus comes within the definition of bribery, and ethically has the same character. There is no doubt that many railroad officers, including directors, have such interests, and receive such rewards, and think they do no wrong. Another sermon would be needed to discuss this fully. The topic is commended to the consideration of our clerical brethren whose vocation it is to awaken the consciences of sinners.

There remains for consideration on the present occasion only

Fifthly and lastly. What is the cure for bribery in railroads?

As it is largely a moral question, of course the evil to a very great extent must be overcome by moral agencies. At present such practices are tolerated, condoned, and are condemned, as it were, in a whisper. Open condemna-

tion of the practice is the purpose of this sermon. Let every person with a clear conscience express his or her opinion freely on the subject.

In Bacon's time the receiving of gifts and bribes by judges was tolerated. His trial and sentence, owing to the eminent position which he held, made the abuse thereafter infamous. Doubtless a similar result would now follow a like cause. Let one or more railroad men of greater or lesser prominence be tried, convicted, and disgraced, and it will make bribery on American railroads infamous, as it did in English courts more than 250 years ago.

In conclusion, we will quote once more the words of our text:

THE RIGHTEOUS ALSO SHALL HOLD ON HIS WAY, AND HE THAT HATH CLEAN HANDS SHALL BE STRONGER AND STRONGER.

NEW PUBLICATIONS.

CHEMICAL TECHNOLOGY; OR, CHEMISTRY IN ITS APPLICATIONS TO ARTS AND MANUFACTURES: EDITED BY CHARLES EDWARD GROVE AND WILLIAM THORP. VOLUME I: FUEL AND ITS APPLICATIONS: BY E. J. MILLS AND F. J. ROWAN. Philadelphia; P. Blakiston, Son & Company, 1012 Walnut Street.

It is impossible—and would, indeed, be unjust to the authors—to attempt an exhaustive review of a volume of this kind on short notice. Its value can only be learned after a period of use as a book of reference, and therefore any extended or critical notice must be postponed until a later date. It is sufficient to say at present that this volume is the first of a new edition based upon the Mechanical Technology of Richardson and Watts, greatly enlarged, rewritten, and brought up to the present date.

The first volume, on Fuel, is naturally one of the most important and practical in its direct applications. It contains chapters on Wood; on Peat; on Charcoal; on Coal; on Coke; on Artificial Fuel; on Liquid Fuel; on Gaseous Fuels; on the Different Applications of Fuel; on Ovens; on Furnaces, etc., etc. Great pains have been taken to collect information from all possible sources and to include the results not only of experiments, but of practical working in a number of different directions. The general plan and scope may, perhaps, best be shown by the following extract from the Preface:

> In fact, the progress in this department has been such that this volume, although founded on the earlier one, is really a new work, and this remark will necessarily apply also to the volumes on Lighting, etc., which will follow. Where possible, historical matter from the old edition has been retained, especially on account of its great value in the case of processes or appliances which are capable of being made the subjects of patents. It is not too much to say that many patents owe their existence to ignorance concerning what has been done in the matters of which they treat; and manufacturers would often find historical information of great use if it were available without laborious searching through Patent Office records.
>
> The subjects of the manufacture of gas for illumination, methods of lighting by oil and gas, the manufacture of candles, the distillation of coal, shale, wood, and peat, with the secondary products obtained therefrom, miners' safety-lamps, and other lamps used for lighting, have been excluded from this volume, which is consequently restricted to the consideration of Fuel and its Applications.
>
> Where possible the duty obtained from the fuel in furnaces has been quoted, and general rules have been given by which the duty of any stated furnace or heating appliance may be estimated.

The book is very fully illustrated, as, indeed, the nature of the subject requires, and includes a large number of tables giving fuel statistics, analyses of different fuels, and comparative results. It has, what every book of the kind should, but does not always have, a very full index.

THE AMERICAN RAILWAY: ITS CONSTRUCTION, DEVELOPMENT, MANAGEMENT, AND RESOURCES: BY VARIOUS AUTHORS. New York; Charles Scribner's Sons (price, $6).

The railroad articles, the publication of which was begun in *Scribner's Magazine* a year and a half ago, have developed into this handsome volume, which includes the various articles published in the *Magazine*, which have been revised by the authors, with a brief introduction written by Judge Thomas M. Cooley, Chairman of the Interstate Commerce Commission, and a supplement of a statistical character written by Fletcher W. Hewes. Probably most of our readers have seen the articles in their original form. It is sufficient to say that they include accounts of the construction of the railroad and its rolling stock; of engineering feats; of safety appliances; of the methods of conducting passenger and freight business; of the details of railroad management, and of the every-day life of railroad men, with chapters on the economic and social relations of the railroad, on the relation of the railroad to its employés, and on railroad mail service, all written by experts in the various departments. Judge Cooley's introduction is a brief but clear exposition of the present lack of system and co-operation among the different roads in the important matter of rates and through business. The statistical supplement gives an interesting collection of maps and tables, showing the geographical distribution and business of the railroads of the country.

The book is not an exhaustive or scientific treatise on railroads, but it contains a great body of information presented in a popular form, and should be of interest to almost all reading people. It is profusely illustrated and the mechanical execution is excellent, making it a very attractive volume of over 450 pages.

EVERYBODY'S HANDBOOK OF ELECTRICITY. WITH GLOSSARY OF ELECTRICAL TERMS AND TABLES FOR INCANDESCENT WIRING: BY EDWARD TREVERT. Boston, Mass.; Damrell & Upham; Lynn, Mass.; The Lynn Book Agency (price 25 cents).

Electricity is a pretty extensive subject to be treated in a book of 120 pages; but this does not make any pretense of completeness, the Author having only attempted to give an outline of the progress made to date with electric lighting, motors, etc., and a popular explanation of the methods usually adopted in generating electricity, the construction of dynamos, batteries, etc. Considering it only as what it claims to be, it is worth attention, and will be of service to the large class who have not time to give to a special study of the subject, but wish to form a general idea of what has been done, and of how it has been done. Perhaps the general explanations have been somewhat too much condensed, and might have been clearer had more space been given to them and less to descriptions of special appliances; and some improvement might have been made in the illustrations. Not too much is to be expected in a book of this kind, however; and it may be considered a very convenient handbook for those who are interested in the

subject—and there are few intelligent people now who do not want to know something about it.

BOOKS RECEIVED.

The Steam-Engine and the Indicator: their Origin and Progressive Development; Including the most Recent Examples of Steam and Gas Motors; with the Indicator, its Principles, its Utility, and its Application: by William Barnet Le Van. Philadelphia; Henry Carey Baird & Company, 810 Walnut Street (470 pages, 205 illustrations; price $4).

Test of Strong Locomotive No. 1, *A. G. Darwin*, and Engines 41, 136, and 31 of the New York, Lake Erie & Western Railroad. New York; issued by the Strong Locomotive Company.

The Making of a Great Magazine. New York; Harper & Brothers.

The Development of the Philosophy of the Steam Engine. An Historical Sketch: by Robert H. Thurston. New York; John Wiley & Sons, No. 15 Astor Place (price, 75 cents).

Elementary Building Construction and Drawing: by Edward J. Burrell. London and New York; Longmans, Green & Company.

Steam: by William Ripper. London and New York; Longmans, Green & Company. This is a treatise on Steam and Its Economical Use, which will receive more extended notice hereafter.

United States Geological Survey, Monograph No. XIV. Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley: by John S. Newberry. Washington; Government Printing Office.

United States Geological Survey, Monograph No. XIII, with Atlas. Geology of the Quicksilver Deposits of the Pacific Slope: by George F. Becker. Washington; Government Printing Office. The Atlas accompanying this Monograph is a beautiful specimen of map-making, as, indeed, are all the maps of the Geological Survey.

Bulletin of the United States Geological Survey, Nos. 48–53. Washington; Government Printing Office. Each of these numbers treats of a different subject, as follows: No. 48. Form and Position of the Sea Level. No. 49. Latitudes and Longitudes of Certain Points in Missouri, Kansas, and New Mexico. No. 50. Formulas and Tables to Facilitate the Construction and Use of Maps. No. 51. Invertebrate Fossils from the Pacific Coast. No. 52. Subaërial Decay of Rocks and Origin of the Red Color of Certain Formations. No. 53. Geology of Nantucket. All are fully illustrated.

American Institute of Architects, Twenty-second Annual Convention, held in Buffalo, October 17–19, 1889: A. J. Bloor, Editor. New York; issued by the Institute.

Transactions of the Institution of Civil Engineers of Ireland, for the 53d Session, to June, 1888: Volume XIX. Dublin, Ireland; published for the Institution.

Reports of the Consuls of the United States; No. 108, September, 1889: prepared by the Bureau of Statistics, Department of State. Washington; Government Printing Office.

Highway Improvement: by Colonel Albert A. Pope. This is a reprint of an excellent address delivered before the Carriage-Builders' National Association at its meeting in Syracuse, N. Y., in October, by Colonel Pope, of Boston.

The Whistle Signal: a Plea for the More Safe Management of Railroads: by Robert Barclay, A.M., M.D. St. Louis, Mo.; published by the Author.

Methods of Laying Concrete Under Water. New York; issued by John G. Goodridge, Jr.

The Westinghouse—Edison Case. New York; published by the Edison Electric Light Company. This is a pamphlet containing the full text of Judge Bradley's opinion in the case of the Consolidated Electric Light Company against the McKeesport Light Company in the United States Circuit Court in Pittsburgh.

Steam Plants for Driving Dynamos in Electric Lighting, Railroad, and Power Stations: Catalogue and Description. St. Louis; issued by the Pond Engineering Company. This is a new and enlarged edition of the Pond Company's pamphlet on this subject, in which the benefit of a large experience in furnishing and erecting such plants is shown.

The Tabor Steam Engine Indicator: Catalogue and Description. The Ashcroft Manufacturing Company; New York and Bridgeport, Conn.

York Manufacturing Company: Catalogue of Steam Engines, Boilers, etc. York, Pa.; issued by the Company.

The Jarman Ice and Refrigerating Machinery: Catalogue and Description. York, Pa.; issued by the York Manufacturing Company.

Taylor Manufacturing Company: Catalogue of High-speed, Automatic Cut-off Engines. Philadelphia and Chambersburg, Pa.; issued by the Company.

Engineering and Other Instruments of Precision: the American Transit Instrument. Philadelphia; Young & Sons, Manufacturers.

The Judson Pneumatic System for Street Railroads: Illustrated Description. New York; issued by the Judson Pneumatic Street Railway Company, No. 45 Broadway.

Steam Boilers Practically Considered: Fourth Edition, 1889. St. Louis, Chicago, Kansas City, and Omaha; issued by the Pond Engineering Company. This is a new edition of a very useful and practical treatise published by the Pond Engineering Company.

ABOUT BOOKS AND PERIODICALS.

In the Journal of the Military Service Institution for November, Lieutenant H. L. Hawthorne writes of an Interoceanic Canal between the Atlantic and Pacific chiefly in its strategic relations. The Use of Railroads in War, by Lieutenant Carl Reichmann, is a careful paper, and includes some account of the services rendered during our own great war by railroad men, who have been rather neglected by most war writers.

In Sensitive Flames and Sound Shadows, in the Popular Science Monthly for November, Professor Stevens gives an example of careful study and analysis of a physical question. The Art of Cooking, by Edward Atkinson, and a note on Science in Domestic Economy will be of value to all of us who have to do with household arrangements—and who has not?

Poverty and Charity in San Francisco, is an interesting study of industrial and economic conditions in California in the Overland Monthly for November. This magazine ought to be read by every one who wants to keep up with current opinion among our brethren on the Pacific Coast; and it contains much matter that is of interest everywhere.

The account of the Mexican Army in Harper's Magazine

for November will be appreciated by military readers. In the same number Señor Becerra gives a condensed account of the Republic of Colombia, in which he shows the extent of the resources of that country, and the urgent need of railroads, steamboats, and other means of communication for their development.

One of the most carefully studied articles in the November SCRIBNER'S is on the Effect on American Commerce of an Anglo-Continental War, by J. Russell Soley, U.S.N. The electrical article for the month is medical rather than mechanical, treating of the Effect of Electricity on the Human Body.

The articles on the Portuguese in the Track of Columbus are concluded in the last quarterly number of the BULLETIN of the American Geographical Society. The Geographical Notes in this number include a very interesting one on the Deep Troughs of the Oceanic Depressions—that is, the deep valleys which hydrographic surveys have shown to exist under the ocean.

The November CENTURY continues Mr. Kennan's account of the mining regions of Eastern Siberia. A short note and an energetic letter on International Copyright are worth reading, and there is a letter on the Use of Oil to Still the Waves. The purely literary part of the magazine need hardly be referred to here, except to say that it is well maintained, as usual.

Among other interesting articles in the MAGAZINE OF AMERICAN HISTORY for November is one on the First Iron Works in America, some notes from which will be found on another page.

The London ELECTRICIAN will continue next year the publication of its *Electrical Trades Directory and Handbook;* the issue for 1890 will be the eighth yearly number of this work. It is intended to include the names of electrical engineers and manufacturers in other countries as well as in England, and the publishers have taken considerable pains to make the list as complete as possible. It is the only publication of the kind, we believe, and ought to be a very useful one for all interested in electrical matters.

A LIGHT SWITCHING LOCOMOTIVE.

THE accompanying illustration shows a four-wheel switching locomotive built by H. K. Porter & Company in Pittsburgh, for Carnegie, Phipps & Company, and used at the Homestead Steel Works of that firm for hauling ingots and other heavy material. The engine is of 30-in. gauge, and weighs in working order 27,500 lbs. The driving-wheels are 28 in. in diameter, and as some of the curves in the shop tracks are very sharp, the wheel-base in this engine was made only 4 ft. Some of the curves over which the engine is in daily use are only 40 ft. radius; and it may be mentioned here that smaller engines built by the same firm are in use over curves of only 16½ ft. radius. The journals on the driving-axles are 4$\frac{1}{16}$ in. in diameter and 4¾ in. long.

The boiler is of the ordinary type, and is 31¾ in. in diameter of barrel; it has 66 tubes 1¾ in. in diameter, and 6 ft. 5 in. in length. The fire-box is 36 in. long inside, 16½ in. wide at the bottom, and 25 in. at the top, and is 40 in. in depth. The grate area is 4½ sq. ft. The chimney is 9⅞ in. inside diameter.

FOUR-WHEELED SWITCHING LOCOMOTIVE.

BUILT BY H. K. PORTER & COMPANY, PITTSBURGH, PA.

The cylinders of this engine are 10 in. in diameter and 14-in. stroke. The steam ports are ⅞ × 7⅝ in. in size and the exhaust ports 1¼ × 7⅝ in. The eccentrics have 2⅝-in. throw. The valves have $\frac{5}{16}$-in. outside lap, and their greatest travel is 2¼ in. The exhaust nozzles are double, and are 1⅝ in. and 2 in. in diameter.

Owing to the small size of the wheels, the engine looks somewhat low. The center of the boiler is 3 ft. 9 in. above the rails, and the total height from the rail to the top of the chimney is 9 ft. 8 in. As will be seen from the engraving, water is carried in a saddle-tank placed over the boiler, and having a carrying capacity of 500 gallons.

A number of engines of this pattern are in use at the same works and in the same service, and Porter & Company are now building some other locomotives of the same gauge to be used for hauling fluid metal in cars built specially for the purpose. They are also building a very small locomotive to be used for hauling ingots and blooms through the rail mill at the Edgar Thomson Steel Works, which is of the same general type as the one shown herewith.

ON STRESSES PRODUCED BY SUDDENLY APPLIED FORCES AND SHOCKS.

BY MANSFIELD MERRIMAN.

WE are all familiar with the theorem that a force suddenly applied to a bar or beam produces double the stress caused by the same force when gradually applied. It is, indeed, the basis of some of the practical rules for proportioning the members in bridge structures and in machines. In this article I purpose to examine the mechanical grounds upon which this theorem rests, to show the distinction between a "suddenly applied force" and a "shock," and to compare the stresses produced by shocks with those that occur under static loads.

Let a bar be subject to a static force P acting in the direction of its length as a force of tension. Then the stress in the bar is also P, and this has produced a small elongation in its length. If the elastic limit of the material is not exceeded, the bar will spring back to its original length on the removal of the force.

If this force P be applied to the bar gradually by small increments, so that the force slowly increases from o up to the amount P, the stress in the bar increases in like manner, and if the elastic limit is not exceeded the elongation e is given by the well-known formula,

$$e = \frac{P\,l}{A\,E}$$

in which l is the length of the bar, A the area of its cross-section, and E the coefficient of elasticity of the material.

Now suppose the force P to be applied very suddenly to the end of the bar, as would be the case if a weight P were brought upon it by a quick shock. Then the stress in the bar increases from o up to an amount which is greater than P, and the elongation increases from o up to an amount which is greater than e. A series of oscillations now takes place, until finally the end of the bar comes to rest with the static elongation e and the stress in it is P. For instance, suppose a common spring balance whose spring elongates 1 in. under a steady load of 4 lbs.; and let a weight of 4 lbs. be dropped into the scale-pan from a height of 2 ft. Then it will be seen that the spring elongates about 8 in., thus, for an instant registering a tension of 32 lbs., but the pan immediately ascends until after a few oscillations the pointer comes to rest at the position which registers 4 lbs. This experiment may be easily tried by any one, but in order that the above result may be closely obtained, it is necessary that the scale-pan should be small and be rigidly attached to the spring, so that the work of the falling weight may not be dissipated in heat.

This illustration shows that the maximum stress due to a suddenly applied force or shock is but of momentary duration. Nevertheless, all experience teaches that this should be the stress considered in proportioning the bar, and that it should never be as high as the elastic limit of the material.

Let P be the weight which is dropped from a height h upon the end of the bar, or upon the scale-pan of the spring balance, and let y be the maximum elongation which is produced. The work performed by the falling weight then is

$$k = P\,(h + y),$$

and this must equal the internal work of the resisting molecular stresses. The stress in the bar which is at first o, increases up to a certain limit Q, which is greater than P, and if the elastic limit be not exceeded the elongation increases uniformly with the stress, so that the internal work is equal to the mean stress $\frac{1}{2}\,Q$ multiplied by the total elongation y, or

$$k = \tfrac{1}{2}\,Q\,y.$$

Placing equal these two expressions for the work, thus neglecting the work that may be dissipated in heat, there results the equation

$$\tfrac{1}{2}\,Q\,y = P\,h + P\,y,$$

from which Q can be found when y is known. But, if e be the elongation due to the static load P, the law of proportionality within the elastic limit gives

$$y = \frac{Q}{P}e,$$

and inserting this, and solving for Q, there is found

$$Q = P\left(1 + \sqrt{1 + 2\frac{h}{e}}\right), \qquad (1)$$

which gives the momentary maximum stress. Substituting this value of Q there results

$$y = e\left(1 + \sqrt{1 + 2\frac{h}{e}}\right), \qquad (2)$$

which is the value of the momentary maximum elongation.

After this discussion we are now ready to give satisfactory definitions to the words "shock" and "suddenly applied force."

A shock results when the force P, before its action on the bar, is moving with velocity, as is the case when a weight P falls from a height h. The above formulas show that this height h may be small, if e is a small quantity, and yet very great stresses and deformations be produced. For instance, let $h = 4\,e$, then $Q = 4\,P$ and $y = 4\,e$; also let $h = 12\,e$, then $Q = 6\,P$ and $y = 6\,e$. Or take a wrought-iron bar 1 in. square and 5 ft. long; under a steady load of 5,000 lbs. this will be compressed about 0.0012 in., supposing that no lateral flexure occurs, but if a weight of 5,000 lbs. drops upon its end from the small height of 0.0048 in. there will be produced the stress of 20,000 lbs.

A suddenly applied force is one which acts with the uniform intensity P upon the end of the bar, but which has no velocity before acting upon it. This corresponds to the case of $h = 0$ in the above formulas, and gives $Q = 2\,P$ and $y = 2\,e$ for the maximum stress and maximum deformation. Probably the action of a rapidly-moving train upon a bridge produces stresses of this character.

I have been unable to find any experiments upon bars by which the above formulas can be tested. But in *Van Nostrand's Magazine* for October, 1877, there is an article on Momentum and Vis-viva by J. J. Skinner, in which are presented a number of experiments made upon spiral springs. These springs were suspended vertically and so arranged that falling weights caused them to elongate, and the amount of elongation was measured, as also the force required to cause the elongation. The elongations of the springs under static loads equal to the falling weights are not given, but these are easily determined from the other data and the statement that the stretch was always proportional to the weight, or, in other words, the elastic limit was not exceeded by the extreme stresses. The following are, then, the experimental data, the first column giving the number of the spring, the second that of the experiment, the third the weight in ounces of the falling objects, the fourth the heights in inches through which they fell before striking the spring, and the last the elongations in inches due to the same static weights.

Spring.	Exp.	P.	h.	e.
I	1	14.79	10.44	2.88
II	2	14.79	4.56	1.17
III	3	49.41	2.90	2.59
III	4	49.41	5.80	2.59
IV	5	49.41	10.26	2.59
IV	6	14.79	2.62	0.42
IV	7	14.79	7.72	0.42
IV	8	49.41	3.66	1.40
IV	9	49.41	7.79	1.40

Inserting the values of P, h, and e in formulas (1) and (2), the maximum stress Q and maximum elongation y are computed, and in the following table these are compared with the observed values of Q and y, the last column giving the mean per cent., in which the computed exceeds the observed value and which is very nearly the same for the stresses as for the elongations. Thus for the first experi-

ment the computed stress is 3.1 per cent. greater than that observed, and the computed elongation is 2.9 per cent. greater than that observed, the mean of these being 3.0 per cent. In no case do the two per cents. differ more than 0.2.

Exp.	Observed Q.	Computed Q.	Observed y.	Computed y.	Diff. per cent.
1	55.67	57.37	10.84	11.15	3.0
2	57.88	58.74	4.57	4.64	1.5
3	136.03	138.35	7.12	7.25	1.8
4	162.96	165.08	8.55	8.65	1.2
5	193.91	197.00	10.17	10.33	1.6
6	66.66	69.28	1.89	1.96	3.8
7	102.28	105.67	2.90	3.00	3.4
8	170.91	172.74	4.85	4.89	1.0
9	217.43	221.50	6.17	6.28	1.9

It is seen that for all the experiments the computed stresses and elongations are greater than those observed by from 1.0 to 3.8 per cent. That is to say, all the work of the falling weights was not immediately expended in producing elongation, but a small part was dissipated in heat either by the primitive impact or in other ways. When the falling weight P struck the spring it possessed the energy $P\ h$; when its lowest point of descent was reached the energy $P\,(h + y)$ was stored up in the spring, excepting the small amount lost in heat; after the completion of the oscillations the spring came to rest with the elongation e possessing the potential energy $\frac{1}{2}\ P e$, and then the total work $P\,(h + \frac{1}{2}\ e)$ had passed into heat.

The discussion of the above experiments indicates that the theoretical formulas (1) and (2) closely represent the extreme stresses and deformations caused by shocks due to weights falling upon the end of a spiral spring, provided that the elastic limit of the material is not exceeded. Will a similar agreement exist in the case of stresses in bars caused by shocks? If so, it is clear that the factors of safety used in the past and at present in these cases are too low.

A PROPELLER FOR LIGHT-DRAFT BOATS.

(From *Le Yacht*.)

M. ORIOLLE, of Nantes, France, has devised a new method of propelling vessels of light draft with considerable speed by means of the ordinary screw-propeller.

The screw, of suitable diameter for the engine power, is placed underneath the boat in a recess formed in the flat bottom. In cross-section this recess is semi-circular in form, as shown in fig. 2; in longitudinal section it slopes gradually both ways, fore and aft, from the screw, as shown in fig. 1.

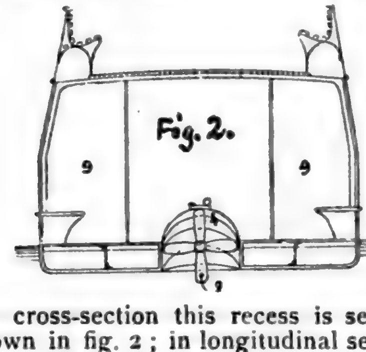


Fig. 2.

The water is drawn in through an opening in the bottom of the boat forward of the screw and passes out through another opening behind it. The screw works in this way in a kind of siphon, in which a circulation is kept up by means of a pump, so that the whole effect of the screw is developed. The form of the siphon or passage is such that the circulation of the water through it will encounter the least possible resistance. In consequence of this arrangement, nearly all loss of power of the screw from centrifugal force is avoided, and the only diminution in the performance is that resulting from the diversion of the stream of water passing through the recess made for the screw.

In the accompanying cuts fig. 1 is a longitudinal section and fig. 2 a cross-section of the experimental boat, which is a double-ender, provided with a rudder at each end. Fig. 2 is on a somewhat larger scale than fig. 1. In these figures 1 is the steering apparatus; 2 the screw; 3 the suction-pipe of the pump; 4 the recess for the screw; 5 the engine; 6 the pump; 7 the boiler; 8 the fire-room; 9 a water-tight door through which access may be had to the screw for repairs, etc.; 10 is the passenger-room.

A boat built on this plan has given very good results so far as tried. This boat is 20 meters (65.6 ft.) long; 3.50 m. (11.5 ft.) in breadth; 0.65 m. (2.13 ft.) in depth, and

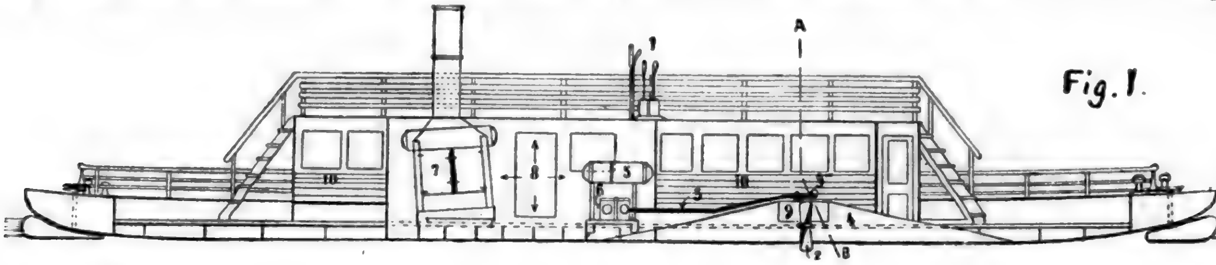


Fig. 1.

draws only 0.25 m. (9.8 in.) of water. The screw is 0.85 m. (2.79 ft.) diameter, and 1.20 m. (3.94 ft.) pitch; the recess made for the screw in the flat bottom extends 3 m. (9.84 ft.) fore and aft of the screw itself.

On the trial trip, on a measured course of 1,850 meters (6,068 ft., or a nautical mile), the boat made a speed equivalent to 8.15 knots an hour, with a light pressure of steam (about 70 lbs.), 300 revolutions of the screw, and the engine developing 40 indicated H. P.

With a full pressure of steam, about 140 lbs., with which the screw can be run up to 450 revolutions, it is believed that there will be no difficulty in reaching a speed of at least 10 knots an hour.

A FRENCH EXPRESS PASSENGER LOCOMOTIVE.

THE accompanying illustrations show a heavy passenger engine exhibited at Paris by the Western Railroad Company of France, and built at the shops of that Company near Rouen. Formerly the type of passenger engine used on the road was one very common in France and on the Continent, with four coupled drivers and a single pair of leading wheels; but when it became necessary to build a heavier engine to meet the requirements of the increasing traffic, it was decided to substitute a truck for the leading wheels, and the present engine is the result. It was built from the designs of M. Clerault, Chief Engineer of Motive Power of the Company.

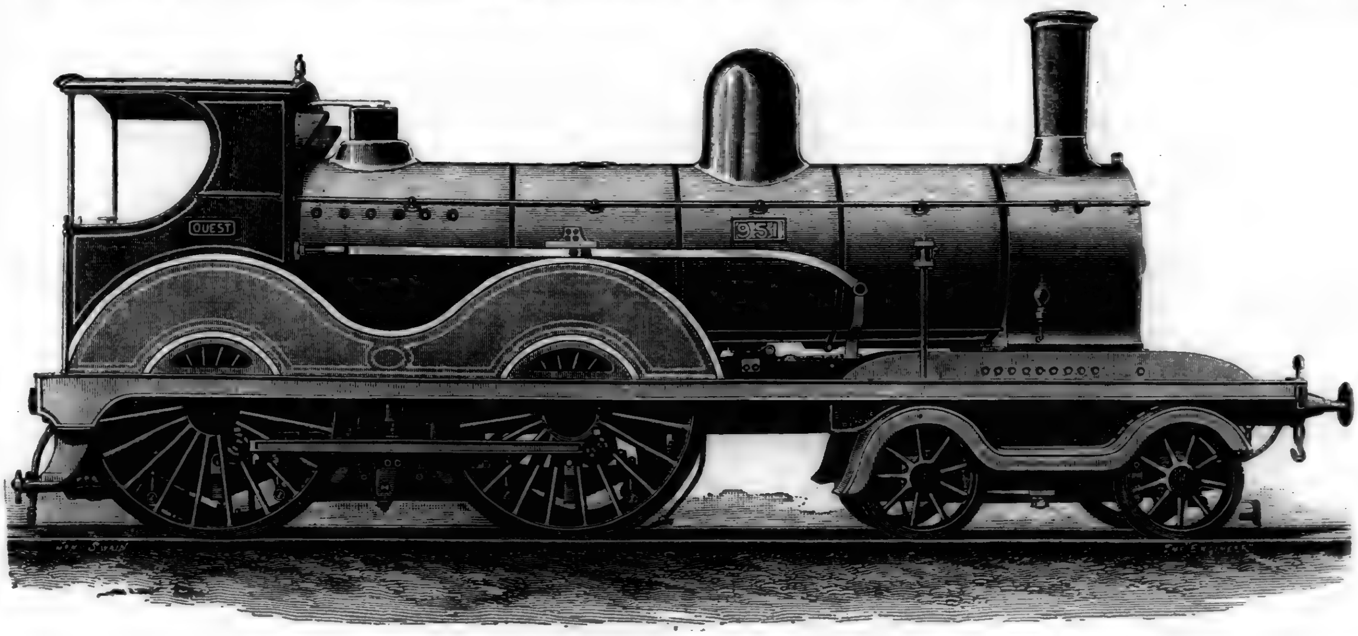
The boiler is of iron, in three rings joined by double butt joints; the fire-box of copper. The crown-bars are of steel made in a single plate, with ends extending beyond the box at each side, and carried on angle-brackets riveted to the sides of the outside fire-box. The smoke-box is of steel plate, but the smoke-box tube-plate is of copper, and the tubes are of brass. The grate is slightly inclined, and is fitted at the front end with a drop-plate worked by a screw.

The cylinders are inside, and the slide-valves are vertical and placed between the cylinders. Steam is taken into the single valve-chest, common to both cylinders, by two steam-pipes, one in front, the other behind. As there is little available space between the box and the slide-valves,

the ports are divided into two lengths, as shown in the smaller illustration, which gives a view of the valve-gear. The exhaust is divided into two branches passing, one straight up, the other below and around the cylinder. The pistons are of the Swedish type, made of forged steel. There are four guide-bars which are arranged in a some-

by a cataract or water cylinder, which serves to lock the gear in any position.

The connecting-rods are of channeled section. The coupling rods are of mild steel, also of channeled section, made with both ends solid. The coupling pins are placed at the same side of the centers as the main cranks on the

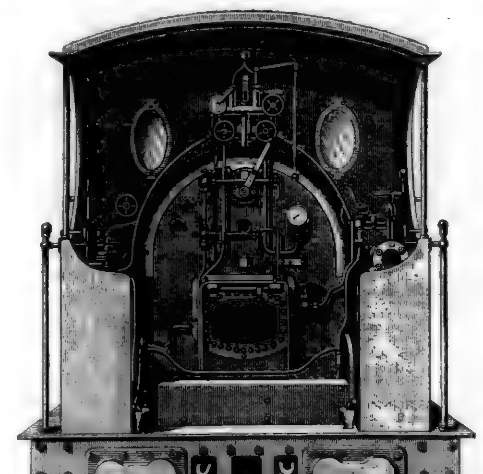


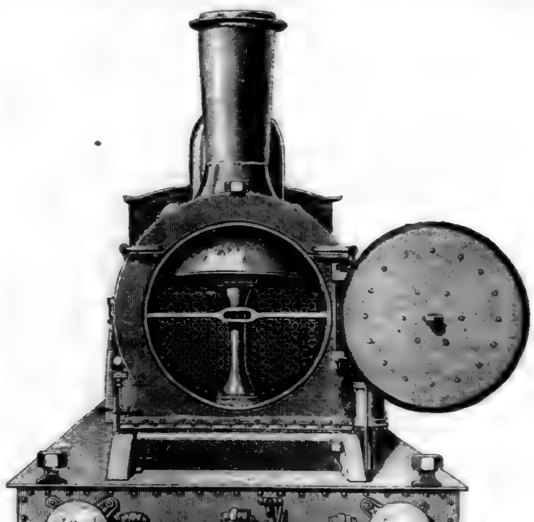
EXPRESS LOCOMOTIVE, WESTERN RAILROAD OF FRANCE.

what novel manner, which is also shown in the smaller engraving. The bars are supported at the center of their length, independently of the cylinder, by a steel casting bolted between the side frames. The valve-gear is a link motion with box-links. The reverse shaft is not fitted with any balancing weight or spring, reversing being

axles. The whole of the revolving weight and about one-third of the reciprocating weight is balanced, one-sixth of the latter in each pair of coupled wheels.

The frames are of the plate type, and are of steel 1 in. thick. Beneath the cylinders is a flat casting which carries the center-pin of the truck. The center-plate on the truck





effected by the steam apparatus, which is illustrated separately herewith.

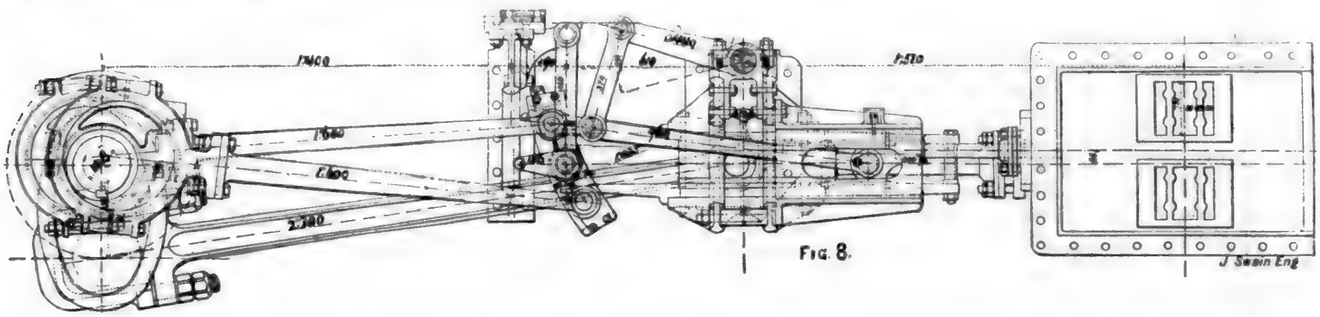
This reversing apparatus is shown in the small engraving, figs. 1–5. Fig. 1 shows the apparatus complete, *E* being the reverse lever and *C* a multiple passage cock on the cylinder; this cock is shown in detail in fig. 4. Fig. 5 is a diagram of the whole arrangement. The reversing shaft is moved by a steam cylinder and piston, controlled

is circular and 2 ft. in diameter, with a projection $9\frac{1}{2}$ in. diameter and $7\frac{1}{2}$ in. long, and through this projection the center-pin, which is 3 in. in diameter, passes. This center-pin is slightly in the rear of the actual center of the truck, an arrangement which is said to give greater ease in going around curves. The truck frames are also of steel plate 1 in. thick. The truck has a slight transverse motion controlled by two plate springs, with an initial ten-

sion of about 1⅓ tons and a deflection of about 1 in. per ton.

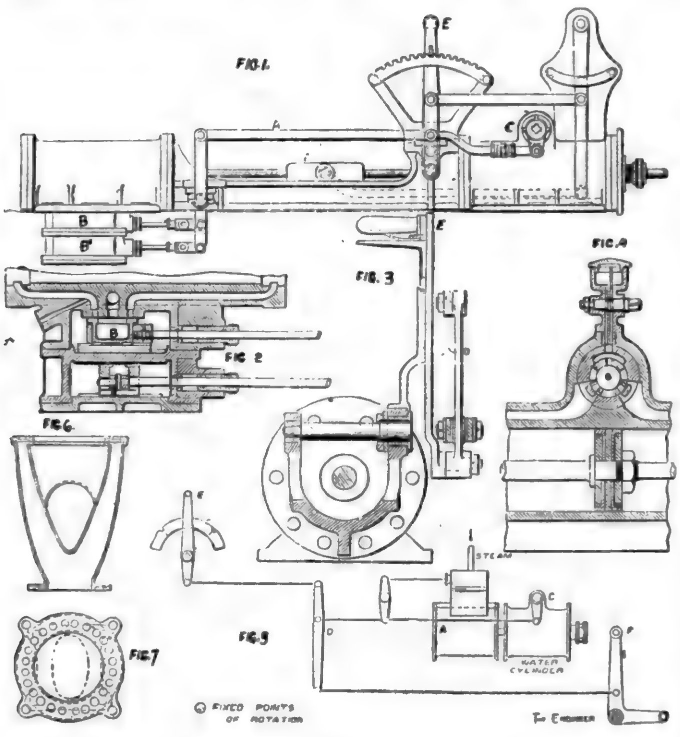
The driving-springs are beneath the axle-boxes, as will be seen, and are connected by an equalizing lever. The axle-boxes are of cast steel. The engine and tender are coupled without the usual spring buffers by oblique buffers, a system which has been in use on this road for some time. Those on the engine have spherical ends and those on the tender are flat and inclined at an angle of about

Total wheel-base	22 ft.	4 in.
Distance between centers of driving-wheels	8 "	11 "
Diameter of driving-wheels	6 "	8½ "
Diameter of truck-wheels	3 "	1 "
Diameter of cylinders		18 "
Stroke of cylinders		26 "
Weight of engine in working order		47⅛ tons
Weight on driving-wheels		29 "
Weight on truck		18⅛ "



50°. This arrangement prevents lateral motion between the engine and tender, but does not prevent the necessary motion in going around a curve.

The engine is provided with Gresham & Craven's steam sanding apparatus. The boiler is fed by two No. 9 Friedman injectors, and the usual working pressure carried is 156 lbs. The blast-pipe, which is shown in section and in plan in figs. 6 and 7, is of the "Vortex" type; above it is



placed a species of hood or petticoat pipe, which is shown in the front view of the engine. This is really a prolongation of the chimney, and is intended to equalize the draft.

The accompanying illustrations, which are taken from the London *Engineer*, show a side view of the engine; a front view with the smoke-box door open; a rear view; enlarged views of the reversing gear, of the blast-pipe, and, in fig. 8, of the valve motion, guides and cross-head.

The principal dimensions of this engine are as follows:

Length of grate	5 ft.	7 in.
Width of grate	3 "	5 "
Depth of fire-box	5 "	6 "
Number of tubes		195
Diameter of tubes outside		2 in.
Length of tubes	13 ft.	8½ "
Diameter of boiler	4 "	1 "
Height of center of boiler above rail	7 "	3 "
Length of engine over all	33 "	5 "

The tender has four wheels only and carries 2,300 galls. of water, which is a sufficient supply for the run from Paris to Rouen, 86 miles. The wheel-base of the tender is 9 ft. 8 in.; great care has been taken to keep down its weight as much as possible. Its total weight ready for work is only 25 tons, and of this the water weighs nearly 10 tons and the coal 3¼ tons.

THE INTERNATIONAL RAILROAD CONGRESS.

[Dr. Victor Roll, in *Zeitschrift für Eisenbahnen und Dampfschiffahrt*, Vienna.]

A PROMINENT French journal characterizes the proceedings of the Congress in these words: "The discussions on most of the points were long and careful, and the resolutions presented to the full house were carefully prepared."

We are hardly able, in spite of all good will, to hold so good an opinion of the result of the Congress; it seems to us rather that in the proceedings the necessary care and thoroughness were wanting. The fault certainly cannot be attributed to the many prominent persons who took part in the Congress, and who tried, to the best of their ability, to forward its objects; the fault is rather with the organization.

In the first place, it seems to be of doubtful propriety that each management should be allowed to appoint an optional number of representatives, each one of whom appears for himself as an independent member of the Congress; that the most insignificant local roads and street railroads—the Paris Exposition Railroad appeared as a participant in the Congress—car-trust companies, sleeping-car companies, and similar organizations should be admitted to the Congress. On such a plan it is clear that the membership will increase to many hundred persons, and it will consequently become a very unwieldy body. Now it is true that the questions to be discussed will be considered in the different sections; but how do we find it in these? These sections include each more than 100 participants, and their sessions begin at the same time with those of the full Congress.

With this arrangement it is not to be wondered at if the discussions in the sections also miscarry. The too great number of members, and the necessity of making ready for the full meetings of the Congress, and the impossibility of a previous study of the material submitted, cripple the work of the sections, with the result that the conclusions of the reports will not always be the full solution of the problem in hand.

It will appear that from these causes the debates in Paris were still more unfavorably influenced than in the earlier meetings. Men like M. de Bruyn—now the Belgian Minister of Public Works—who led the discussion in the Fifth Section at the Milan and Brussels meetings; Leon Say, who took an active part in the Fourth Section, and others

of weight, were this time unheard, and but seldom gave a word to stir up the discussion.

It would be well to call to mind the example of the German Railroad Union. That body, which numbers in all fewer members than one section of the Railroad Congress, is a representative assembly, which usually accepts without debate the conclusions of its committees.

The committees of the Union also proceed very differently. The number of those chosen by the full meeting for the strongest committee is reduced to 20 or at most 30 members. And even this number is considered too great for the full study of important questions, so that the usual course is to appoint sub-committees to sift out the material submitted and to prepare a summary for their consideration. These summaries and the reports must be sent at least 14 days before the beginning of the meeting to all members of the committee. The committees are assigned a time for meeting before the general meeting, and their reports must be sent before the meeting to all members of the Union.

These arrangements necessarily result in reducing the number of the members of the full meeting and of the sections by regular rules, in completing the work of the sections before the general meeting, and in placing before the members full information on the subject in hand. Thus there is no possibility of the members acting upon insufficient information, or taking part in the debates without understanding fully the question in hand.

On the other hand, it would be very strange if the members of the International Congress could master in a few days—or perhaps hours—the thick volumes, which those who were intrusted with the work submitted to them, in order to take part properly in the discussion.

It must also be said that the work of these gentlemen leaves much to be desired. Truth requires us to say that, while in the majority of the special papers no pains were spared to present a general view of the condition of the question in hand in different countries, their labor alone was too often in vain; the view was too limited, because the questions addressed to the railroad managements remained unanswered. Now it is of very little use for us to learn from an elaborate paper what one French, or Belgian, or Russian road is doing in this or that matter, when we do not know what a hundred other important roads are doing in the same direction.

This result is the more to be regretted, because, had the railroads, generally, taken such interest and given such data as were asked for, a body of information of almost inestimable value as to current railroad practice might have been collected, upon which most valuable conclusions might have been based for future use.

But these criticisms must be sufficient, and must give place to a brief account of what was done, following the programme laid down in advance.

Beginning with Section I, we find that in that division there were seven questions: The first—Question A—related to the Best Material for Rails. Under this head were reported the results obtained by the use of different kinds of steel for rails and rail-joints.

Upon this point M. Von Bricka, Chief Engineer of the French State Railroads, presented results obtained on several French, Austro-Hungarian, Belgian, Swiss, and English lines, on the Spanish State Railroad, and the Swedish Northern. On this question also there were presented notes from Councillor Werchowsky on the researches on steel rails made by the Russian Technical Society, and from M. Hallopeau on the behavior of steel on the Paris, Lyons & Mediterranean lines.

The Congress agreed with the report, and adopted the following vote prepared in the Section:

For the manufacture of rails a very hard steel is to be preferred, provided it be of good quality and nearly free from phosphorus. The greatest possible degree of hardness that can be obtained without injuring the quality of the steel depends upon the methods used in its manufacture and upon the raw material used. The use of steel for rail fastenings is continually increasing; for the joint-plates steel of medium hardness is preferred; for the bolts and spikes soft steel (flusseisen).

Question B related to the rules governing the wear of rails. On this point an elaborate paper was read by M. Louis de Busschere,* Chief Engineer of the Belgian State Railroads. His opinion was that the experiences reported under this head were not sufficiently extended to establish any general rules, and he recommended a careful series of observations, on which a report could be based for the next meeting of the Congress. He presented a table or formula for the reports to be obtained from the different railroad managements. The objects to be gained are to ascertain the amount of wear resulting from the passage of a given number of trains or of tons weight over the rail under differing conditions of alignment, grades, etc. The points to be noted in the reports asked for are:

Method of laying the rails; characteristics of section chosen for observation; maximum grade and minimum radius of curvature; method of manufacture of the rails; endurance per square millimeter of wear; length of the rails; section of the rails; weight per meter; average moment of inertia; greatest weight on an axle; average age of the rails; number of rails removed on account of breakage, longitudinal cracks, or any other cause.

The report was approved and the different managements were requested to make the trials, on one or more sections of road.

Question II, A, related to the comparative merits of the double-headed and Vignoles rails for lines of very heavy traffic. The report made by MM. de Bemelmans and Brunerel, of the Belgian State Railroads, gave a summary of the history of this question. The report, with which the Section agreed, recommended the double-head rail for lines with heavy traffic and fast trains, and the Vignoles pattern for lines of lighter traffic. Nevertheless both forms of rail are considered safe when well made.

It is to be noted, however, that, owing to the few managements which answered the questions, these conclusions were rather based on the experience of a single road than on any comparison of general practice.

Division B treated of the best method of fastening rails (Vignoles type) to wooden ties, by screw-spikes or ordinary spikes. The report on this subject was made by Herr Hohenegger, Engineer of Maintenance of Way of the Austrian Northwestern Railroad, who reached the following conclusions:

1. The ratio 90:100 between the breadth of the base and the height of the rail is generally preferable.
2. Steel tie-plates increase the stability of the superstructure on high grades.
3. The perforation of the ties is done best by the wedge-shaped spike.
4. On the inner side of the rail the screw-spike shows greater endurance, on the outer side the ordinary spike.
5. Spikes offer more resistance than screw-spikes both to lateral movement and to creeping of the rails.

Further investigations were held desirable, especially on the second point.

On this point also there was much difference of opinion in the Section. As to the others, the conclusion was that the spike is to be preferred for cold climates, or for ties of soft wood; the screw-spike for warm climates, or for hard-wood ties.

In Division C, on Rail-joints, the report was presented by M. Pieron, Chief Engineer of the Northern Railroad of France, and related chiefly to experience in that country. The conclusions reached by the Section were as follows:

1. In relation to the rail-joint, the suspended joint (between ties) seems to be generally preferred to the supported joint (resting on tie). The distance between the joint ties varies from 60 to 70 cm. (23.6 to 27.6 in.).
2. The angle-plate offers no advantages over the straight joint-plate or fish-plate.
3. The better the design of rail-section, the lighter can the joint be made.
4. The number of bolts to a joint is usually four.
5. To prevent bolts becoming loose, the only remedy is to screw the nuts up as tight as possible.

Division D was the question of the best permanent way for lines where trains are run at high speed. The report was made by M. Michel, Chief Engineer of the Paris,

* A summary of M. Busschere's paper was published in the RAILROAD AND ENGINEERING JOURNAL for November.

Lyons & Mediterranean Railroad, and the decisions of the Section are given below :

Rails : The weight of the rails can, for the double-headed type, vary from 40 to 45 kg. per meter (80 to 90 lbs. per yard) ; for the Vignoles type, from 42 to 52 kg. per meter (85 to 105 lbs. per yard). The length of the rail should be from 9 to 12 meters (29.5 to 39.4 ft.) and the width of the rail-head from 60 to 72 mm. (2.36 to 2.83 in.).

Fastenings : The rail should have three or four fastenings to each tie. For the Vignoles type the screw-spike is preferred.

Joints : The splice-bars should be as long and heavy as possible. The general practice is to use the angle-joint.

Ties : The distance between joint-ties should be from 48 to 66 cm. (19 to 26 in.) ; between the other ties, from 75 to 91 cm. (29.5 to 35.8 in.).

Ballast : The main point is that care should be taken in the choice of materials.

Road-bed : The main points are that the road-bed should be thoroughly drained and ample support provided for the ties.

Locomotives : The type of engine most used for high speed is now that having a truck forward.

In the discussion on this question many interesting facts were brought out as to the effect of fast trains on the track, and on other points.

Question III brought up the point whether in laying track on iron bridges it is best to interpose wood between the rails and the bridge girders ; and whether it is best to lay the track on longitudinal sleepers or cross-ties. The report was presented by Sr. Randich, of Italy, and the conclusions reached were somewhat indefinite. It was considered that neither system presented such advantages as would warrant a general expression of preference. The use of iron cross-ties was thought to present some advantages.

Under Question IV, the operation of signals and switches from a distance, or from a central station, M. Sabouret, of the Orleans Railroad (France) presented a careful report on the practice on different lines.

The conclusions of the Congress were that, while the system to be adopted must depend largely upon local conditions, in general terms it might be said that for distances up to 50 meters the transmission of the required power to operate the signals or switches by rigid rods or bars was to be preferred ; from 50 to 200 meters the choice must depend upon the circumstances in each case ; over 200 meters the transmission by wire ropes must be considered preferable. As to hydraulic, pneumatic, and electric transmission, their use is still too limited to permit any general rules.

Question V related to the best means of transferring cars from one track to another parallel one—switching, turn-tables, or transfer-tables. The report was presented by M. Briere, of the Orleans Railroad, and the Section recommended in general terms the use of transfer-tables, while admitting that local conditions must largely govern the means adopted.

Question VI—the Ventilation of Tunnels—was presented in a report by Sr. Candellero, of Italy. This was considered by the Second and Third Sections together, and the conclusion was that further trials with natural and artificial ventilation were very desirable ; also trials of apparatus for ventilating properly and removing from the tunnel smoke, gas, etc.

Question VII was divided into three parts. Under Division A, Herr von Leber, of the Austrian General Inspection, presented a long report in two parts, the first suggesting a fixed nomenclature for bridge construction and parts of bridges ; the second giving rules and formulas for bridges of different material (steel, mild steel, and iron), for limits of safety, strains, etc. His suggestions were approved by the Congress.

Under Division B, M. Von Bricka, of the French State Railroads, presented a long report on the breakage of rails, treating of the causes of breakage, material of rails, manner of breakage, effects of temperature on breakage, and many other points.

Under Division C, M. Kowalski, of the Bona-Guelma Railroad (Algiers), presented a report on the use of metallic ties, which was supplemented by notes from the Netherlands State Railroad and from several Swiss lines.* The conclusion reached was that, while metallic ties present many favorable points, the experience with them was not yet extended enough to warrant any final decision in their favor as against wooden ties.

The Section and the Congress adopted the suggestion made in the report for further trials. This was that each management should select two trial sections of 500 to 1,000 meters each, one to be laid with metal ties, the other with new wooden ties ; both to be as nearly as possible under the same conditions of grade, curvature, drainage, condition of road-bed, ballast, etc. The points to be observed and reported are first cost ; cost of maintenance ; cost of renewals ; durability or life of ties ; effect on rails ; best types or forms of tie, and general cost, taking into consideration all renewals. These trials should last some time in order to arrive at a just conclusion.

(TO BE CONTINUED.)

EXPERIMENTAL AID IN DESIGNING STEAMSHIPS.

(From the *Steamship*.)

THE achievement of one triumph after another in the matter of high-speed steamships, and especially the confidence with which pledges of certain results are given and accepted long before actual trials are made, form one of the most convincing proofs of the important part which scientific methods play in modern shipbuilding. This is evident in the case of ships embodying novel or hitherto untried features, and more especially so in cases where shipbuilders, having no previous personal practical experience or data, achieve such results. This was notably illustrated in the case of the Fairfield Company undertaking some five years ago to build and engine a huge craft of most phenomenal form and proportions, and to propel the vessel at a given speed under conditions which appeared highly impracticable to many engaged in the same profession. The contract was proceeded with, however, and the Czar of Russia's wonderful yacht *Livadia* was the result, which (however much she may have justified the professional strictures as to form and proportions) entirely answered the designer's anticipations as to speed. Equally remarkable and far more interesting instances are the Inman liners *City of Paris* and *City of New York*, in whose design there was sufficient novelty to warrant the degree of misgiving which undoubtedly existed regarding the Messrs. Thomson's ability to attain the speed required. In the case at least of the *City of Paris*, Messrs. Thomson's intrepidity has been triumphantly justified. An instance still more apposite to our present subject is found in the now renowned Channel steamers *Princess Henrietta* and *Princess Josephine*, built by Messrs. Denny, of Dumbarton, for the Belgian Government. The speed stipulated for in this case was 20½ knots, and although in one or two previous Channel steamers, built by the Fairfield Company, a like speed had been achieved, still the guaranteeing of this speed by Messrs. Denny was remarkable, in so far as the firm had never produced or had to do with any craft faster than 15 or 16 knots. The attainment not only of the speed guaranteed, but of the better part of a knot in excess of that speed, was triumphant testimony to the skill and care brought to bear upon the undertaking. In this case, at least, the result was not one due to a previous course of "trial-and-error" with actual ships, but was distinctly due to superior practical skill, backed and enhanced by knowledge and use of specialized branches in the science of Marine Architecture. Messrs. Denny are the only firm of private shipbuilders possessing an Experimental Tank for recording the speed and resistance of ships by means of miniature reproductions of the actual vessels, and to this fact may safely be ascribed their confidence in guaranteeing, and their success in obtaining, a speed so remarkable in itself and so much in excess of

* The note on the experience of the Swiss lines with iron ties was translated and published in the RAILROAD AND ENGINEERING JOURNAL for October.

anything they had previously had to do with. Confirmatory evidence of their success with the Belgian steamers is afforded by the fact that they have recently been instructed to build for service between Stranraer and Larne a paddle-steamer guaranteed to steam 19 knots, and have had inquiries as to other high-speed vessels.

In estimating the power required for vessels of unusual types or of abnormal speed, where empirical formulæ do not apply, and where data for previous ships are not available, the system of experimenting with models is the only trustworthy expedient. In the case of the Czar's extraordinary yacht, the *Livadia*, already referred to, it may be remembered that, previous to the work of construction being proceeded with, experiments were made with a small model of the vessel by the late Dr. Tideman, at the Government Tank at Amsterdam. On the strength of the data so obtained, coupled with the results of trials made with a miniature of the actual vessel on Loch Lomond, those responsible for her stipulated speed were satisfied that it could be attained. The actual results amply justified the reliance placed upon such experiments. The design of many of Her Majesty's ships have been altered after trials with their models. This was notably the case in connection with the design of the *Medway* class of river gunboats. The Admiralty constructors at first determined to make them 110 ft. long, by only 26 ft. in breadth. A doubt arising in their minds, the matter was referred to the late Mr. Froude, who had models made of various breadths, with which he experimented. The results satisfied the Admiralty officers that a substantial gain, rather than a loss, would follow from giving them much greater beam than had been proposed, and this was amply verified in the actual ships.

So long ago as the last decade of last century, an extended series of experiments with variously-shaped bodies, ship as well as other shapes, were conducted by Colonel Beaufoy, in Greenland Dock, London, under the auspices of a Society instituted to improve Naval Architecture at that time. Robert Fulton, of America, David Napier, of Glasgow, and other pioneers of the steamship, are related to have carried out systematic model experiments, although of a rude kind in modern eyes, before entering on some of their ventures. About 1840 Mr. John Scott Russell carried on, on behalf of the British Association, of which he was at that time one of its most distinguished members, an elaborate series of investigations into the form of least resistance in vessels. For this purpose he leased Virginia House and grounds, a former residence of Roger Stewart, a famous Greenock shipowner of the early part of the century, the house being used as offices, while in the grounds an experimental tank was erected. In it tests were made of the speed and resistance of the various forms which Mr. Russell's ingenuity evolved—notably those based on the well-known steam line theory—as possible types of the steam fleets of the future. All the data derived from experiment was tabulated, or shown graphically in the form of diagrams, which, doubtless, proved of great interest to the *savants* of the British Association of that day. Mr. Russell returned to London in 1844, and the investigations were discontinued.

It will thus be seen that model experiments had been made by investigators long before the time of the late Dr. William Froude, of Torquay. It was not, however, until this gentleman took the subject of resistance of vessels in hand that designers were enabled to render the results from model trials accurately applicable to vessels of full size. This was principally due to his enunciation and verification by experiment of what is now known as the "law of comparison," or the law by which one is enabled to refer accurately the resistance of a model to one of a larger size, or to that of a full-sized vessel. In effect, the law is this—for vessels of the same proportional dimensions, or, as designers say, of the same lines, there are speeds appropriate to these vessels, which vary as the square roots of the ratio of their dimensions, and at these appropriate speeds the resistances will vary as the cubes of these dimensions. The fundament upon which the law is based has recently been shown to have found expression in the works of F. Reech, a distinguished French scientist, who wrote early in the century. There are no valid grounds for supposing that the discovery of Reech was familiar to Froude; but even were this so, it is abundantly evident that, although never claimed by himself, there are the best of grounds for claiming the law of comparison, as now established, to be an independent discovery of Froude's.

Dr. Froude began his investigations with ships' models at the experimental tank at Torquay about 1872, carrying it on uninterruptedly until his death in 1879. Since his decease, the work of investigation has been carried on by his son, Mr. R. E. Froude, who ably assisted his father, and originated much of the existing apparatus. At the beginning of 1886 the whole experimental appliances and effects were removed from Torquay to Haslar, near Portsmouth, where a larger tank and more commodious offices have been constructed, with a view to entering even more extensively upon the work of experimental investigation. The dimensions of the old tank were 280 ft. in length, 36 ft. in width, and 10 ft. in depth. The new one is about 400 ft. long, 20 ft. wide, and 9 ft. deep. The new establishment is more commodious and better equipped than the old, and although the experiments are taken over a greater length, the operators are enabled to turn out results with as great dispatch as in the Torquay tank. The adjacency of the new tank to the dockyard at Portsmouth enables the Admiralty authorities to make fuller and more frequent use of it than formerly. Since the value of the work carried on for the British Government has become appreciated, several experimental establishments of a similar character have been instituted in other countries. The Dutch Government in 1874 formed one at Amsterdam which, up till his death in 1883, was under the superintendence of Dr. Tideman, whose labors in this direction were second only to those of the late Dr. Froude. In 1877 the French naval authorities established an experimental tank in the dockyard at Brest, and the Italian Government have just completed one on an elaborate scale in the naval dockyard at Spezzia. The Spezzia tank, which is 500 ft. in length by about 22 ft. in breadth, is fully equipped with all the special and highly ingenious instruments and appliances which the scientific skill of the late Dr. Froude brought into existence, and have been since his day improved upon by his son, Mr. R. E. Froude, and other experts. Through the courtesy of our own Admiralty and of Messrs. Denny, of Dumbarton, the Italians have been permitted to avail themselves of the latest improvements which experience has suggested, and the construction of the special machinery and apparatus required has been executed by firms in this country having previous experience in this connection.

Having briefly traced the origin and development of the system of model experiment, it may now be of interest to describe the *modus operandi* of such experiments, and explain the way in which they are made applicable to actual ships. The models with which experiments are made in those establishments conducted on the lines instituted by Mr. Froude, are made of paraffin wax, a material well adapted for the purpose, being easily worked, impervious to water, and yielding a fine smooth surface. Moreover, when finished with, the models may be remelted for further use and all pairings utilized. They are produced in the following manner: A mold is formed in clay by means of cross-sections made somewhat larger than is actually required, this allowance being made to admit of the cutting and pairng afterward required to bring the model to the correct point. In this mold a core is placed, consisting of a light wooden framework covered with calico and coated with a thick solution of clay to make it impervious to the melted paraffin. This latter substance is run into the space between the core and the mold and allowed to cool. This space, forming the thickness of the model, is usually from ¾ in. for a model of 10 ft. long to 1¼ in. and 1½ in. for one of 16 and 18 ft. long. When cold, the model is floated out of the mold by water pressure and placed bottom upward on the bed of a shaping machine, an ingenious piece of mechanism devised by the late Dr. Froude, to aid in reducing the rough casting to the accurate form. The bed of this machine, which travels automatically while the machine is in operation, can be raised or lowered to any desired level by adjusting screws. A plan of water-lines of the vessel to be modeled is placed on a tablet

geared to the machine, the travel of which is a function of the travel of the bed containing the model. With a pointer, which is connected by a system of levers to the cutting tools, the operator traces out the water-lines upon the plan as the machine and its bed are in motion, with the result that corresponding lines are cut upon the model. The cutting tools are swiftly revolving knives which work on vertical spindles moved in a lateral direction (brought near or removed from each other), according to the varying breadth of the water-lines throughout the length of the model, as traced out by the operator's pointer. In this way a series of longitudinal incisions is made on the model at different levels corresponding to the water-lines of the vessel. The model is now taken from the bed of the machine and the superfluous material, or projection between the incisions, is removed by means of a spokeshave, or other sharp hand-tool, and the whole surface brought to the correct form and made fair and smooth.

To test accuracy of form, the weight of the model is carefully taken, and the displacement at the intended trial draft accurately determined from the plan of lines. The difference between the weight of the model and the displacement at the draft intended is then put into the bottom of the model in the form of small bags of shot, and by unique and very delicately constructed instruments for ascertaining the correct draft, the smallest error can at once be detected and allowed for. The models vary in size from about one-tenth to one-thirtieth of the size of the actual ship. A model of the largest size can be produced and its resistance determined at a number of speeds in about two days or so.

The mode of procedure in arranging the model for the resistance experiment, after it is afloat in the tank at the correct draft and trim, consists in attaching it to a skillfully devised dynamometric apparatus secured to a lightly constructed carriage. This carriage runs on a railroad which extends the whole length of the tank about 15 in. or 18 in. above the water. The floating model is carefully guided in its passage through the water by a delicate device, which keeps it deviating either to the right or the left, but at the same time allows a free vertical and horizontal motion. The carriage, with the model attached, is propelled by an endless steel wire rope, passing at each end of the tank around a drum driven by a small stationary engine, fitted with a very sensitive governor, capable of being so adjusted as to give any required speed to the carriage and model. The resistance which the model encounters in its passage through the water is communicated to a spiral spring, and the extension this spring undergoes is the measure of the model's resistance. The amount of the extension is recorded on a revolving cylinder to a much enlarged scale through the medium of levers or bell-cranks, supported by steel knife-edges resting on rocking-pieces. On the same cylinder are registered time and distance diagrams, by which a correct measure of the speed is obtained. The time diagram is recorded by means of a clock attached to an electric circuit, making contact every half-second, and actuating a pen which forms an indent on what would otherwise be a straight line on the paper. The distance-pen, by a similar arrangement, traces another line on the cylinder.

From these time and distance diagrams accurate account can be taken of the speed at which the model and its supporting carriage have been driven. Thus, on the same cylinder are recorded graphically the speed and resistance of the model. The carriage may be driven at any assigned speed by adjusting the governor of the driving engine.

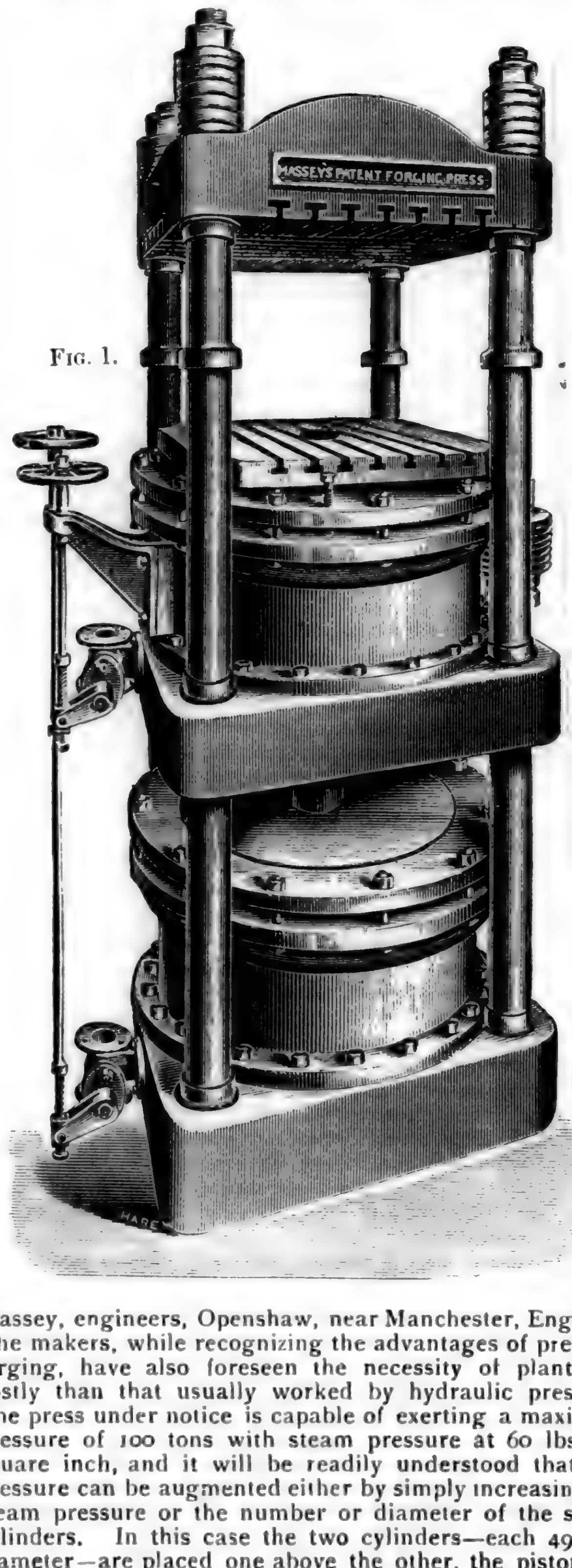
When the resistances of the model have been obtained at several speeds, varying in some cases from 50 ft. to 1,000 ft. per minute, the speeds are set off in suitable units along a base-line, and for every speed at which resistance is measured, the resistance is set off to scale as an ordinate value at those speeds. A line passing through these points forms the curve of resistance, from which the resistance experienced by the model at the given trial speeds, or any intermediate speed, can be ascertained. The resistance being known, the power required to overcome it and drive the ship at any given speed is easily deduced by applying the rule before described as the law of comparison.

A COMPOUND STEAM FORGING PRESS.

(From *Industries*.)

THE accompanying illustrations, figs. 1 and 2, represent a general view and a front elevation of a compound steam forging press, now being introduced by Messrs. B. & S.

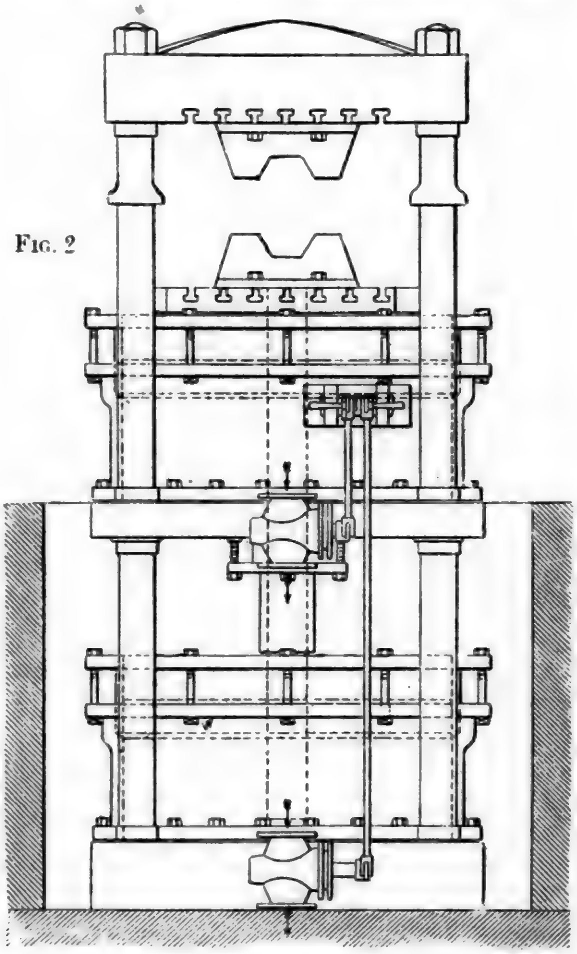
FIG. 1.



Massey, engineers, Openshaw, near Manchester, England. The makers, while recognizing the advantages of pressure forging, have also foreseen the necessity of plant less costly than that usually worked by hydraulic pressure. The press under notice is capable of exerting a maximum pressure of 100 tons with steam pressure at 60 lbs. per square inch, and it will be readily understood that this pressure can be augmented either by simply increasing the steam pressure or the number or diameter of the steam cylinders. In this case the two cylinders—each 49½ in. diameter—are placed one above the other, the piston-rod of the lower one being arranged to work through the upper cylinder, the stroke in both cases being 15 in. Steam is admitted direct from the boiler into the cylinders, the valves being so arranged that the pistons can be worked either conjointly or separately as required. Thus for light work one cylinder alone can be used, or, while one piston is made to act upon a pair of dies, the other piston can

drive a punch through the metal held in the dies. The height between the table and the top, when the former is in its lowest position, is 24 in. The table itself measures 4 ft. 2 in. square, is provided with T grooves on its upper surface for fixing the tools, and is guided between four massive pillars. We are informed that Messrs. Massey have one of these presses working at 60 lbs. pressure at their own works, and forging in it 2¾-in. square-headed bolts at one stroke, in common cast-iron dies. The makers claim for this press several advantages—viz., small first

FIG. 2



cost; cheapness of erection, a steam pipe from the boiler being the only fixing required; cheapness of working; speed in action, in consequence of the elastic property of steam; and absence of vibration or noise during working.

AN ENGLISH VIEW OF OUR NAVY.

(From the *Army and Navy Gazette.*)

THE announcement made within the last day or so that a squadron of United States men-of-war of modern construction will shortly arrive in European waters serves to remind us of the notable results of the new departure in regard to naval matters taken during the administration of ex-President Cleveland. One of the most important arguments used by Lord George Hamilton when introducing his resolution on the Navy in March last, was based upon the unusual tendency which so many powers have recently shown to increase their naval strength. As the First Lord pointed out with much force 18 years ago, or even less, there was only one considerable naval power in Europe, while the feature of the present situation is that there are now not one or two, but four or five nations which are spending largely on their naval armament. Italy, Germany, and Austria, but especially the first-named power, have practically created navies since the time when Mr. Childers was at the Admiralty. Russia, too, whose navy then was almost entirely built for defense, is now strong on the seas for offense as well; while we cannot forget that Turkey, which had a fairly good fleet, no longer possesses one. Other powers, like Brazil, Chili, Japan and China, have acquired some remarkably fine and powerful ships; and, more recently, Spain has evinced a determination to re-enter the arena on which so many of her former successes were gained and her former prowess was so frequently exhibited. But though it may be that it is with the increase of European navies we are principally concerned, Englishmen cannot help being interested also in the remarkable strides which have been taken in this direction on the other side of the Atlantic, where the rehabilitation of the Navy of the United States is being pushed ahead with the characteristic energy of our American cousins. If, perchance, there are any who have not taken note of what there is going on, the imminent advent of four new and important cruisers in our waters should direct their attention that way. It is not so much, however, that the United States have made a very good beginning toward building up a modern Navy—this is but a trifle where "money is no object"—but there have also been developed in the country facilities of every kind for the creation of that Navy without outside assistance. This can hardly yet be said of any other power except France and Great Britain. In 1885, it was not only the case that the United States had no vessel-of-war which could have kept the seas for one week as against any first-rate naval power, but they were absolutely dependent upon our manufactories for forging of guns, for armor, for machine and rapid-fire guns, and the like. Now, four years later, not only has much been done in the way of constructing vessels which are as good as anything of similar type afloat, but arrangements have been made by which they will be able shortly to create entirely from their own resources every modern implement of war, including steel-clad battleships of the heaviest tonnage, with their guns and armor. By the end of this year the Bethlehem Iron Company, of Bethlehem, Pa., one of the largest steel manufactories in the States, has guaranteed to have erected the plant for the production of armor and gun forgings of the largest kind. Other companies have taken in hand the supply of war material, and within the last month three or four firms have tendered for the construction of cruisers and a similar number for the provision of steel projectiles. Moreover, there is now nearly completed at Washington an ordnance factory for finishing heavy naval ordnance, and all the necessary plant for handling gun-forgings up to the quantity required to make the very largest gun afloat. Nearly half a million sterling has been expended, or is in course of expenditure, on this factory alone. Of developments which we may call by comparison minor, there is the opening of a new dock, 460 ft. by 79 ft. by 27½ ft., at Mare Island, San Francisco, and another at Norfolk, Va., within the last fortnight, which is 600 ft. by 93 ft. by 25 ft. The Americans have quite evidently realized that as they are obliged to spend money on a Navy, the disbursements may as well be for their own benefit as not. In fact, ex-Secretary of the Navy Whitney, to whose exceptional executive talents and business ability these results are mainly due, might well have used in his valedictory address the words used by Lord George Hamilton not long ago:

"The great bulk of expenditure in the Navy goes in the cost of providing additional ships and other equipments. All that money is spent in this country, and it simply takes the shape of accelerating and encouraging our first national industry—the building of ships."

From the foregoing, it will be seen that the United States are in earnest in the intention of resuming their position as a naval power. It is, however, somewhat significant that at present all this construction seems to tend in the direction of vessels more fitted to run away from an antagonist of real weight than to sustain the glorious tradition of the American sea service. With but one or two exceptions, these ships are better prepared to destroy commerce than to protect it. There is no sign of a fleet fitted to cope with European armor-clads if they crossed the Atlantic as they have done before. After all, though, it is better to crawl before trying to run, and we may yet see designed, laid down and built by native talent in a United States Navy-yard that crux of naval construction, the "battle-ship of the future."

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.*

I. WHAT THE CHEMIST DOES.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

THE question has often been asked what a chemist can have to do on a railroad, and the query is a very natural one. Those whose ideas of modern railroads are based on what they see when a train passes by, have very little conception of the infinite detail in the work required to produce this result. Those best informed in such matters, however, know that no phase of human effort in modern times makes demands on so many sources of knowledge, or utilizes under one general management, so many of the useful arts, as a modern railroad does. The relation between the Chemist and the movement of trains, and the carrying of passengers and freight, is not at all apparent at first sight. That chemistry plays no insignificant part in the final result, it is hoped will be made clear by what follows:

The reason why experts in any branch are employed by railroad companies, is found in the fact that there are constantly a large number of questions arising before railroad operating officers, which questions require for their solution, some knowledge of the laws of nature, and that the average operating officer is not generally fitted by training or acquired information, to obtain satisfactory answers from nature with reference to these questions, and even if he be so fitted, he has not the time to make experiments. Many such questions can be answered by the Civil Engineer or the Mechanical Engineer; many of them require for their answer, experiments in the domain of heat, light, or electricity, or physical tests, and some of them can only be answered by the Chemist. This has led to the employment of experts in two fields—namely, those who make physical experiments and tests, commonly called Engineers of Tests, and experts who make chemical experiments and tests, known as Chemists. It is interesting to note that during the last 15 years the recognized place of chemistry in the operation of railroads has grown to such an extent, that now no less than nine of the large railroad corporations of the country have a regularly employed Chemist. In some places this Chemist is also the Engineer of Tests, or, in other words, the general scientific expert, who makes both the physical as well as the chemical tests.

It is, perhaps, fair to say that when the question came up some 14 years ago of employing a chemist on the Pennsylvania Railroad, so little was the possible uses of such an expert appreciated, and so little work was known that he could do on a railroad, that permission to have a chemist was granted more as a concession and as an experiment than with any faith or belief that the scheme would prove to be permanent or valuable. It is also fair to say that at that time the field for work was as much unknown to the Chemist himself as to the railroad officers, and that for the first two or three years of the life of the laboratory, progress was necessarily very slow in consequence. It was not only necessary for him to have the chemical knowledge requisite to do the work when it was once in hand, but it was also necessary for the Chemist and officers both to study carefully the practical problems involved in railroad operation, and find the work for the laboratory to do. Chemists starting in on railroads at the present time, find a large amount of work ready for their hands, as the result of the work already done in this field, and it is not at all difficult now for one who has had two or three years' experience in one of the older railroad laboratories, to show marked results from his first or second year's work. It is, of course, clear that as the number of railroad chemists increase, they gradually expand the field, and necessarily give mutual help to each other, both by direct communication, and by the effects of their work on the manufacturers. The field is so large, however, that even though the number of chemists was increased four or fivefold, there would be, we think, no lack of new work for them to do for a number of years to come.

The Chemist having been secured, one of the first things that is usually given him, is to explain some peculiarity that has been observed in the service. The first work done after the laboratory of the Pennsylvania Railroad was established, was to make an investigation into the reason why the valves and steam cylinders corroded so badly. The ordinary life of a valve was about a year, and whenever an engine came in for repairs, there was always more or less corrosion about the seat where the steam-chest rests on the cylinder. A careful study was made of the conditions, and the conclusion reached was that the difficulty was due principally to the acids in the tallow used for lubricant, and that corrosion was assisted by the sponginess of the castings in the valves, since the cavities in the castings afforded places for the lodgment of the tallow. At the time this investigation was started, no record could be found in the literature of the case to show that the fat acids characteristic of tallow would corrode iron at the temperature of steam cylinders, and direct experiments were made with these acids demonstrating this point. The explanation of the difficulty having been obtained, of course attention was directed toward securing a mitigation of the trouble. The details of this subject will be presented later.

As another illustration of the application of chemistry to bad results obtained in service, the following may be cited: One of the special cars after having been cleaned by the car-cleaners was noticed to look badly, and on examination by the Foreman of Painters, it was declared that the varnish had nearly all been removed by the cleaning. As a matter of discipline, the Foreman Car-Cleaner was asked to explain why the varnish had been so badly used, and he claimed he could do no better with the soap he had. A sample of the soap used was submitted to the Chemist, who found not less than 3 per cent. of caustic soda, and 7 per cent. of carbonate of soda, in addition to the soda combined with the fat as legitimate soap. This, of course, explained the peculiarity and justified the foreman, as the soap solution used in washing the car was in reality a concentrated solution of sal soda and lye, which readily dissolves varnish.

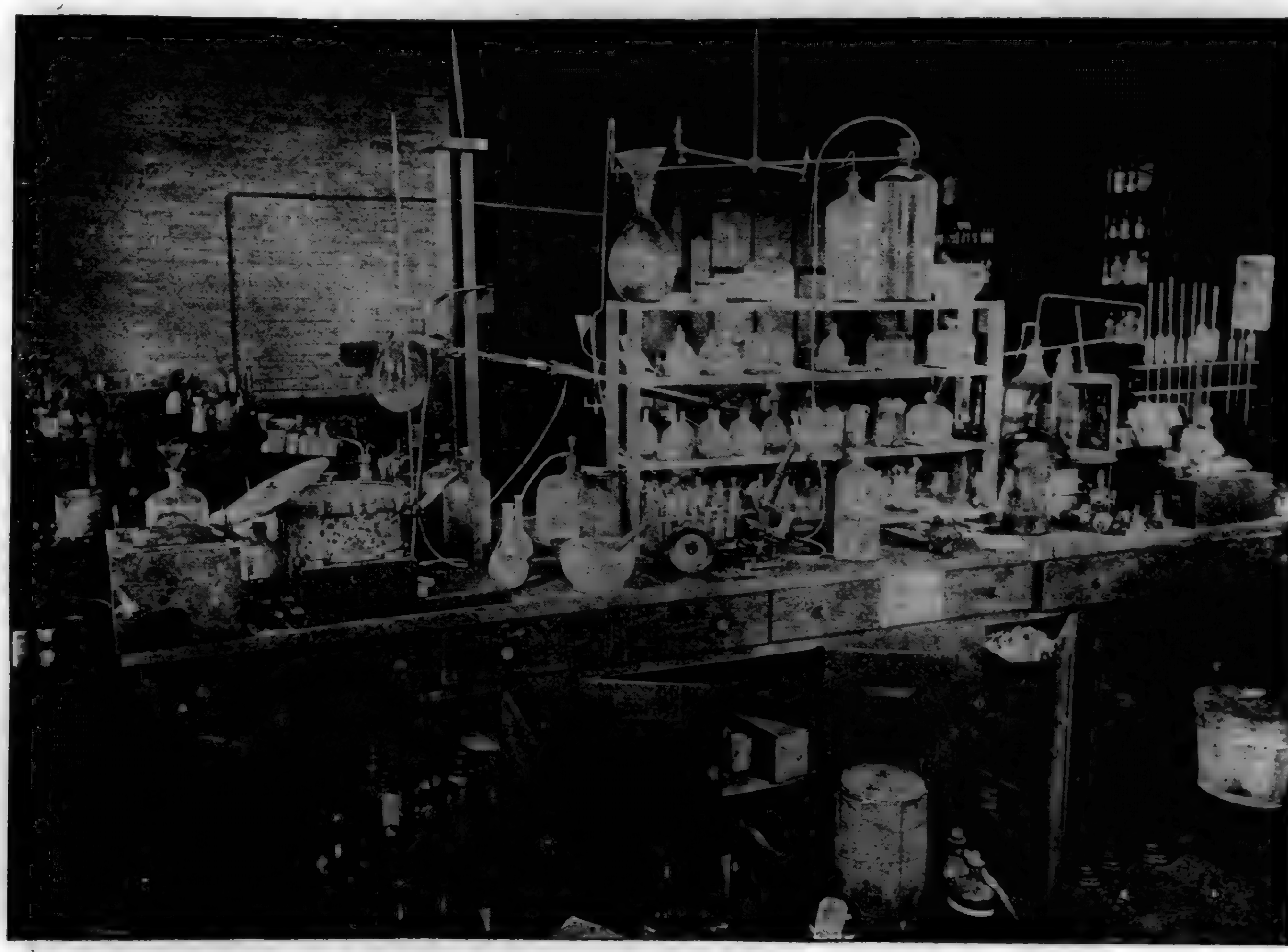
Another field for the activity of the Chemist of a railroad is to protect against fraud. Not a few cases could be cited, showing attempts to sell at excessive prices, under some special name, common articles, which can be obtained in the market at very small figures. One of the most common of these attempts is that of selling some cheap materials for use as anti-incrustating boiler compounds. Dry material has been offered at 25 cents per lb., which on examination has been found to be nothing but sawdust and sal soda. Again, boiler compounds have been offered at 50 cents per gallon, which have been found to be apparently spent tan liquor, containing a little sal soda, 95 per cent. of the material being water simply. A very common field, likewise, is the one of alloys. Some composition of metal, which can be made at a slight excess over the cost of the metals entering into it, is offered under a special name, at two or three times the cost of the ingredients. Disinfectants are likewise another special field for imposition. Ordinary sulphate of iron, or copperas, which can be purchased in the market at 90 cents per 100 lbs., has been offered under some high-sounding name at 10, 15, or 20 cents per lb. This list could be enlarged to almost any extent. One of the most recent instances which has come to our notice is that of a material to protect iron from rusting, which was offered under a special name at from 15 to 25 cents per lb. On examination it proved to be nothing more than ordinary 500° fire-test petroleum, known in the market as cylinder stock, and which can be bought at from 1½ to 2 cents per lb. by the 100 barrels, if required. That the material is

* This is the first of a series of articles relating to various subjects connected with the operation of railroads, upon which more or less definite information has been obtained in the Motive Pewer Department of the Pennsylvania Railroad during the last 15 years. They are contributed by permission of Mr. Theodore N. Ely, General Superintendent of Motive Power of that line, and the earlier articles will be devoted more especially to Railroad Supplies.

efficient and good for the purpose, is common knowledge, and it is difficult to see how any one could offer such material for sale at the price above mentioned, and call it legitimate business.

Another line of activity of the Chemist is to prove whether the assertions made by commercial men are true or false. It is common experience with railroad officers, especially Purchasing Agents, to meet men having materials for sale, for which they claim most extraordinary results. Houses engaged in legitimate trade claim for their products much better results than those obtained from the goods of their rivals, and between the representations of different firms of equally good standing, the Purchasing Agent, who is anxious to get the best thing, is often sorely puzzled. Almost the whole realm of supplies used by railroads is subject to this peculiarity, and it is difficult to pick out examples. Possibly paints, oils, and greases, are most commonly misrepresented in this way. The statements made by the men anxious to sell are often not only absurd, but laughable in the extreme to persons who are well informed. The representative of a certain grease offered for general lubrication, recently called upon us, to set forth the merits of his wares. In the course of the conversation with him, it was remarked that the usual difficulty with regard to greases, and the cups which were usually used for feeding them, was that, upon the journal getting a little warm, the grease would melt and all run out, leaving the journal without any lubricant whatever, the ordinary control over the feed in the case of grease being obviously inapplicable. To this statement the representative of the grease, with the utmost coolness, and with the evident expectation of being believed remarked that "This grease is entirely unaffected by changes of temperature." Upon our offering to place an order with him for three 10-lb. cans of the grease, to be put in as many museums, and labeled as "The only substance in nature not affected by temperature," he saw the absurdity of his position, and as gracefully as possible modified his statement to one that the material was *only a little* affected by temperature.

Again, not infrequently, parties anxious to sell represent their materials as being first-class in every respect, or in accordance to the specifications then in force. Often this is misrepresentation, and many times parties are perfectly honest and believe what they say, being simply misinformed themselves about their own goods. In either case, if a trial order is placed with them and a shipment made, difficulty often arises in the service, and too late it is found that the material is inferior. To such an extent is this the case, that at present it is quite the custom when a new party desires to furnish materials for the use of the Pennsylvania Railroad, to require him to send a sample of his material for examination before the Purchasing Agent feels willing to place an order with him. The saving in annoyance and vexatious disputes by this method is no small relief, not only to the Purchasing Department, but also to those who have to use the materials.



INTERIOR OF PENNSYLVANIA RAILROAD LABORATORY AT ALTOONA.

It is not, of course, claimed that chemical verification of the statements of commercial men, is the only method open to the puzzled railroad officer. Often his practical men can make tests sufficiently accurate to decide many of the questions, but no small number of assertions can only be checked up in a chemical way, although it should be fairly confessed that time and the whole resources of our chemical knowledge frequently fail to put a quietus on the misrepresentations of those who are anxious to sell.

Another field of activity for a good chemist on a railroad is to make investigations, to guide the practices of the road, and the expenditures of money. One or two illustrations will probably make this point clear. It is well known that natural waters, as they occur along the line of a road, must necessarily be used in the boilers for steam generation. It is also well known by those who are at all familiar with the subject, that waters differ very widely from each other in their value for steam purposes. Almost all waters contain more or less mineral matter dissolved in the water, which, when the water is boiled away, is left behind as a hard residue in the boiler, commonly known as boiler scale, and the waters that must be used vary from, perhaps, three grains to the gallon, up to as high as 40 or 50 grains per gallon of scale-making material. It has for quite a long time been the practice of the Pennsylvania Railroad to establish no new water stations until all the sources of water supply in that region have been examined as to the scale-making properties of the waters, and it is known that much good has resulted from this examination. Oft-times an expenditure of a number of thousand dollars, and the establishing of a poor water station, is avoided by so simple a thing as the determination of the total solid residue left on evaporating a sample of the water. The saving in boiler repairs and coal resulting from only using the best water accessible, is hardly capable of calculation, but those who are best informed on the subject will not hesitate to assent to the statement, that it amounts to thousands of dollars per year on any railroad having as many as 100 locomotives.

Another example in this line will make the matter still more clear. Some four or five years ago, investigations were made in the laboratory of the Pennsylvania Railroad, on the composition of the oil burned in the hand lanterns and elsewhere, and known in railroad language as signal oil. This oil, as is doubtless well known, is a mixed oil, the principal constituents being either lard, colza, or mustard-seed oil, together with varying proportions of petroleum distillate, known in the market as 300° fire-test oil, and as head-light oil. The question to be decided was, What mixtures of these various oils will give satisfactory results at the least possible cost? To solve this problem analyses of various mixtures of signal oil obtainable in the market were made, and then new mixtures were made in various proportions of the oils mentioned above, which were subjected to burning tests. As a result of the whole work, which extended over a period of a month or two, a formula was developed which gave an oil that was perfectly satisfactory by all tests, and at the same time produced a saving at the prices then prevalent of about 10 cents per gallon over the practice then in use. Oil was made according to this formula, and distributed to the men without their knowledge that any change had been made, and quite to the gratification of those authorizing the change, and somewhat to their astonishment, no increase of complaints in regard to oil could be observed. The economy in operating expenses produced by this change amounted to about $15,000 per year.

In addition to the examination of water for boiler use, a chemist on a railroad is not infrequently called upon to examine water for drinking purposes, both in a chemical and hygienic way. The money results of such an examination can hardly be stated, since to say nothing about the direct losses due to sickness and disease, it is, of course, impossible to calculate the detriment to the service due to inefficiency arising from a semi-invalid body.

Still another class of work where a railroad chemist has a chance to exert himself, is found in the testing of new devices offered as possible improvements in the present practices of railroads. A very good example of this are the experiments made on the ventilation of cars some eight or ten years ago, under the direction of the Chemist and the Engineer of Tests of the Pennsylvania Railroad. A new system of car ventilation having the name of the inventor had been developed and put on a single car. The money of a number of "promoters" was invested to the extent of fitting up this car, and the possibilities of a large company to push the matter, and bring the system into general use on railroads, was in prospect. This car was turned over to the two experts, with instructions to devise and make such experiments as would demonstrate whether the new system had any points of superiority over the one at that time in use. Without going minutely into detail, experiments were made on the relative capacity of the two systems to exclude objectionable matter, especially dust and cinders. Various experiments were also made on the capability of the two systems for removing objectionable matter formed within the car. These experiments embraced the relative length of time under normal conditions, that the two cars were freed from smoke and from odors generated in the car. Finally, the two cars were loaded in accordance with their capacity with men from the shops, and a run made, the ventilation being entirely a function of the characteristics of the two systems—that is, no doors or windows were left open. Samples of air were taken from the cars toward the end of the run, and also while standing on the tracks, without opening the doors or windows, to see what the ventilation was when standing still. These samples of air were duly analyzed for carbonic acid, that gas being, as is well known, thrown off by the lungs and body of every person. The results of the tests showed that while the two cars were running, the air in the new car contained from 0.50 to 0.60 per cent. of carbonic acid, while the car fitted with the old system contained from 0 20 to 0.30 per cent. While standing still the old car contained 0.55 per cent. of carbonic acid, and the new car ran up to something over 3 per cent. As the amount of carbonic acid allowable in the air for health, as stated by the best hygienic authorities, is not over 0.10 or 0.15 per cent., it was evident that not only the standard car in use needed attention as to ventilation, but also that the new car offered in competition had no points of superiority sufficient to recommend its adoption. It is, perhaps, needless to say that this investigation produced a complete collapse of the new car-ventilating company. It may be added for information, that analyses of air from cars made under the direction of the State Board of Health of Massachusetts, confirm the analyses of the Pennsylvania Railroad car, as given above; and that it seems probable the average of the air in cars throughout the country during the winter season, at least, is about one-half as good as it should be. In other words, since the ventilation of cars, as elsewhere, consists of taking fresh air into the car and foul air out, one-half as much air per hour is taken into cars in the United States in general, as should be for health, at least, during the winter season.

Perhaps the most important work of the Chemist on a railroad is the investigation in regard to the materials or supplies used, and the examination of shipments to see whether they are what they profess to be. The usual method pursued on the Pennsylvania Railroad is something as follows: Some difficulty arises in the service; the case is investigated, and the cause of the difficulty ascertained. If this difficulty is due to something characteristic of the practice of the road, usually a circular of instruction to the men is prepared, explaining the difficulty, and how to avoid it. A number of such circulars of instruction have already been prepared and issued to the men, with very gratifying results.

If, on the other hand, the difficulty is found to lie in the material or supplies furnished, a careful study of the special material at fault is made. This study may take a year or two before satisfactory conclusions are reached, but ultimately the results of the study are embodied in what are known as "specifications" in printed form, a copy of which specifications accompanies each order for that kind of material. The finding out what substances give the best results in service, or the making of specifications, is not at all an insignificant matter. It involves an intimate knowledge of all the requirements of the material from a railroad standpoint, and an intimate knowledge of all the processes leading up to the commercial product which is in question. Obviously, if the specifications do not give a material which proves satisfactory in service, or if the specifications demand more than the manufacturers can give, they are worthless. During the nearly 14 years' existence of the Pennsylvania Railroad Laboratory, chemical specifications for only about 25 different commercial products have been prepared. In later articles of this series an attempt will be made to give the reasons

why, and a complete explanation of the specifications which have been prepared.

The preparation of the specifications, although a necessary preliminary, is only a small portion of the most important work of a railroad chemist. As long as competition in business is as severe as it is at present, there will be constant temptation on the part of the manufacturers to furnish inferior materials, even though the material is bought on specifications, and here comes the most voluminous work of the chemist—namely, the examination of samples taken from shipments, to see whether they fill requirements. In the Pennsylvania Railroad Laboratory, at the present time, four chemists are engaged on this work the largest portion of each working day. Samples from some 4,000 shipments per year are examined, the average number of determinations per sample being about five. This work, in addition to the examination of miscellaneous samples of material, either for investigation, or to settle some point connected with the service, makes the total number of determinations made in the Pennsylvania Railroad Laboratory somewhere between 25,000 and 30,000 per year.

It will, of course, be understood that the 25 specifications already issued cover only a small portion of the field. The number of kinds of material that do not yet have specifications is large, and the laboratory is constantly expanding in this direction, no less than three or four new specifications being under consideration at the present time.

It sometimes happens that after a subject has been investigated, and satisfactory conclusions reached in regard to the material desired, the obtaining of this material in the market is not easy, or, if it can be obtained, it is only at a high rate. So many difficulties of this kind have occurred, that, in connection with the laboratory, a manufacturing establishment has been started, which already makes a number of articles for the use of the road, notably disinfectant, polishing compound, blue-print solution, battery solutions, etc. It seems probable that this line will necessarily increase, for reasons that will be subsequently stated.

The query will naturally arise in the mind of every railroad man, whether specifying the quality of material does not necessarily increase the price, and, therefore, whether, after all, there is any real advantage in specifications. It is gratifying to be able to state that the experience of the Pennsylvania Railroad, for now nearly 14 years, is in general, that the price is not seriously affected either way by the preparation of specifications. Indeed, in many cases materials on specifications are obtained at lower rates than prevailed before the specifications were issued. The principal reasons for this seem to be, first, that manufacturers, knowing what is going to be used, can provide themselves with the raw materials in larger quantity, and thus get the benefit of reduced rates, and second, all manufacturers in the same line being required to bid on the same requirements, naturally bring their price just as low as it is possible to get it, in order to be sure of getting the business. Whatever the cause, the fact remains.

There is another gratifying result which follows the work of a good chemist on a railroad—and, indeed, the same may be said of any expert work—and that is, if the Chemist, Engineer of Tests, or other expert, is conscientious and competent, and carries his investigations on until he has obtained a complete explanation or solution of the problem in hand, based on some law of nature, the subsequent action taken by the railroad officers in accordance with the results of this investigation is so much more intelligently done, that it is quite apt to be permanent. Many questions have been put at rest, and many standard practices adopted on the Pennsylvania Railroad during the last 14 years, as the result of the studies and investigations of the various experts employed, and many of the problems studied during this time have been so well settled by the investigations made, that few questions in regard to them have subsequently arisen. There are few railroad operating officers, who will not appreciate the freedom from annoyance which results from the satisfactory solution of some knotty problem.

(TO BE CONTINUED.)

THE CAIRO BRIDGE.

THIS notable structure, one of the longest—if not the longest—truss bridges in the world, crosses the Ohio River just above its junction with the Mississippi, at a point where the crossing has heretofore been made by steam ferries, and where, until the recent great development of long-span construction, it was not deemed possible to build a bridge which would not be too serious an obstruction to navigation to be permitted. It connects permanently the Main Line and the Southern Division of the Illinois Central Railroad, the exchange of traffic between those sections of the Chicago-New Orleans Line having increased to a degree which warranted the Company in expending the large amount—some $2,500,000—required to build the bridge.

The bridge has no draw-span, being a high-level bridge placed at such an elevation as to permit the river steamers to pass under it without interference. There are 12 spans in the bridge proper, and 40 shorter spans in the approaches, making its total length a few feet over two miles.

As just stated, the bridge proper over the main river consists of 12 spans resting on masonry piers. Two of these on the northern end and one on the southern end are supported by pile foundations ; the others are built upon caissons. These caissons were all sunk 75 ft. below the low-water level, and rest upon the bottom at that depth, which is very hard clay or compact sand. They were built of squared timber—Southern pine—bolted together, sheathed and caulked outside. They were filled with concrete after they were sunk to their places ; three of them, carrying the piers for the long channel spans, are 30 ft. wide, 70 ft. long, and 16 ft. high, the crib on top being 34 ft. high ; the others are 26 ft. wide, 60 ft. long, and 16 ft. high.

The level of the lower chord of the bridge is 102 ft. above low water, and the piers are consequently about 127 ft. in height from the top of the crib.

The arrangement of the spans of the main bridge is as follows, beginning on the northern or Illinois side of the river : Two spans of 257 ft. each ; two spans of 523 ft. 6 in. each ; one span of 406 ft. ; six spans of 405 ft. each ; one span of 255 ft. The lengths given for the spans are over all, the distance between the centers of the end pins being about 5 ft. less. They are all through spans and are double-intersection trusses, with the upper and lower chords parallel, except the 255-ft. and 257-ft. spans, which are deck-spans with single intersection. The trusses of the two longer spans are 60 ft. 9½ in. deep between centers of pins, and the 405-ft. and 406-ft. spans are 50 ft. in depth. The 255-ft. and 257-ft. spans are 26 ft. in depth. The entire superstructure is of steel.

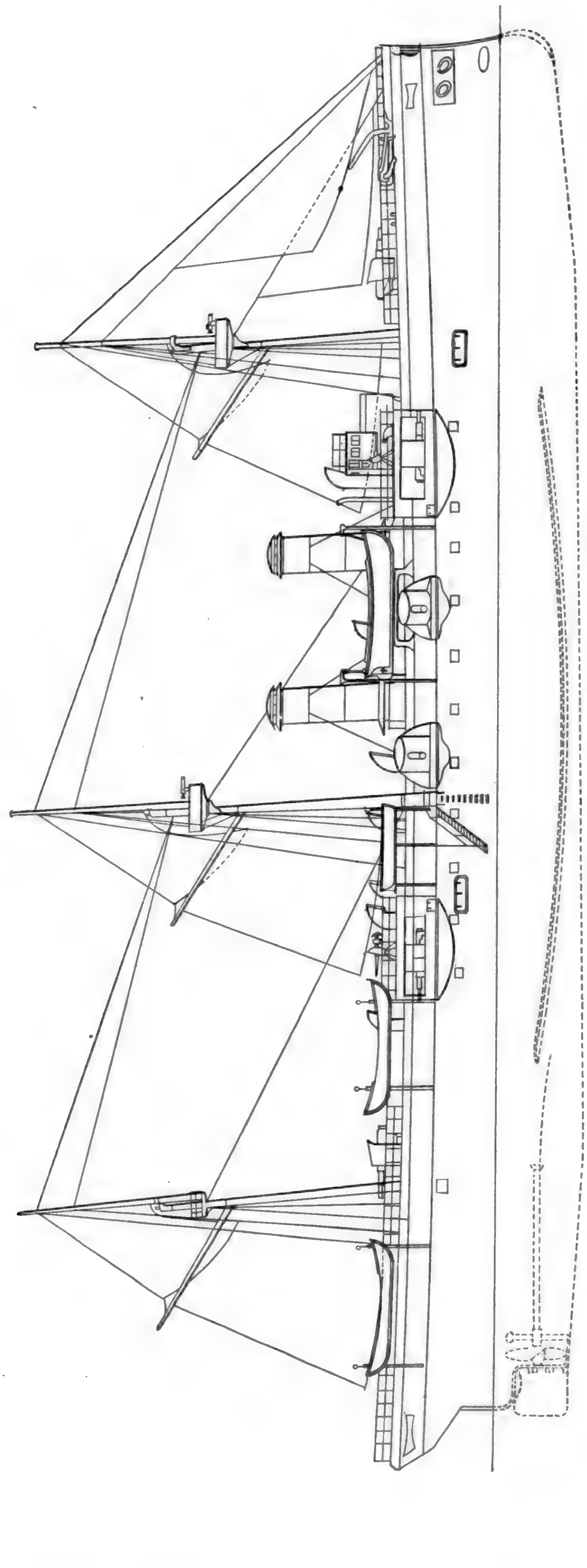
The approaches are by themselves bridges of considerable size. That on the northern or Illinois end consists of 25 spans of 150 ft. each, and that on the southern or Kentucky end of 13 spans of 150 ft. each, and two of 105 ft. each. These approaches are all deck-spans, and rest on piers formed of steel cylinders placed in pairs. These cylinders were sunk to solid bottom, and filled with concrete.

Some very quick work was done in the building of this bridge. One of the 523-ft. spans was erected entirely in 45 working hours, and one of the 405-ft. spans in 31 hours, which is probably the best time ever made in erecting trusses of such great length.

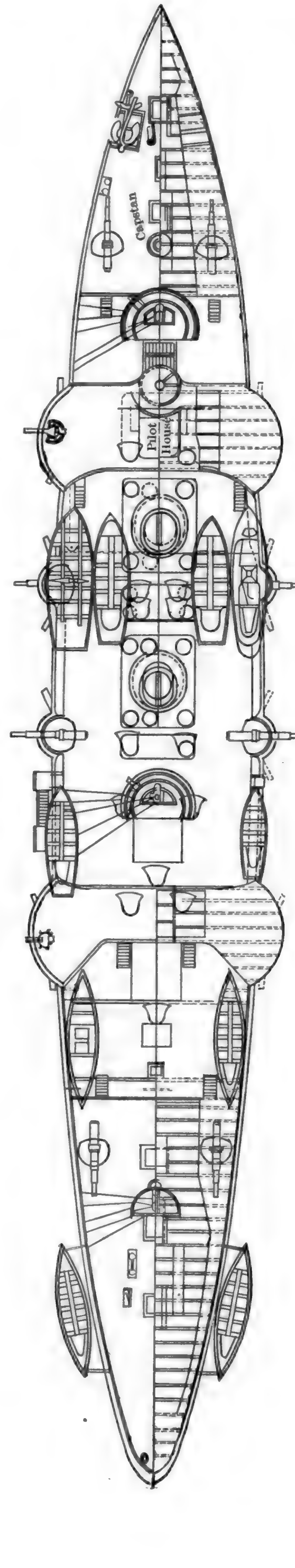
The bridge was designed, and its construction superintended, by Messrs. George L. Morison and E. L. Corthell, Engineers, of Chicago and New York. Mr. Alfred Noble, of Memphis, Tenn., was Resident Engineer during the progress of the work.

The Union Bridge Company was contractor for the entire bridge, and the work on the superstructure was done in its shops at Athens, Pa., and at Buffalo. The foundations and masonry were built by Messrs. Anderson & Barr, as sub-contractors.

Considering the size and importance of the structure, and the great amount of work required on the foundations and piers, as well as on the superstructure, the time taken for its completion was comparatively short. The work was



ELEVATION.



PLAN OF POOP DECK.

CRUISER "SAN FRANCISCO," FOR THE UNITED STATES NAVY.

BUILT BY THE UNION IRON WORKS, SAN FRANCISCO.

begun in August, 1888, and was completed on October 29 last, the whole time taken being thus a little over 14 months.

The Cairo Bridge, as will be seen from this brief description, is entitled to be considered one of the great bridges of the world, and a notable example of American design and construction.

UNITED STATES NAVAL PROGRESS.

UNDER the second call for bids for the 2,000-ton cruisers authorized by the act of September, 1888, five bids were received at the Navy Department. All the bids were of Class I, hull and machinery to be built according to the plans and specifications furnished by the Department. These bids were as follows:

1. Union Iron Works, San Francisco, for one vessel, $775,000; for two vessels, $1,450,000; for all the three, $2,054,001.
2. N. F. Palmer, Jr., & Company for one vessel, $674,000.
3. Columbian Iron Works, Baltimore, for one cruiser, $625,000; for two cruisers, $1,225,000.
4. Bath Iron Works, Bath, Me., for one, two or three cruisers at $675,000 each.
5. Harrison Loring, Boston, for one cruiser, $674,000.

The contract for two of the ships was awarded to the Columbian Iron Works, Baltimore, at their bid of $1,225,000, which was the lowest received. These works have just completed the gun-boat *Petrel;* the two new vessels will thus be built in their yard in Baltimore.

For the third vessel the bids of Palmer & Company and of Mr. Loring were the same, and by agreement between them, the Palmer bid was withdrawn and the contract awarded to Harrison Loring, of Boston, for $674,000. It is understood that he will build the ship, and that the engines will be built by Palmer & Company. The last-named firm are now building the *Concord* and the *Bennington*, the two gun-boats which are nearly completed, and the engines of the armored ship *Maine*, the hull of which is under construction at the Brooklyn Navy Yard.

These 2,000-ton cruisers were described and illustrated in the JOURNAL for July last, page 302. It is sufficient to say that they will be protected cruisers 257 ft. long, 37 ft. in breadth, 19 ft. 6 in. in depth and 14 ft. 6 in. draft. They will have two triple-expansion engines with cylinders 26½ in., 39 in. and 63 in. in diameter and 33 in. stroke. They will carry two 6-in. and eight 4-in. rapid-fire guns, with a number of smaller guns. The original specifications called for a speed of 18 knots, but the bids received under these did not come within the limit of the cost fixed by Congress and new specifications were issued, fixing the speed at 17 knots an hour. The contracts now awarded are, of course, under the amended specifications.

LAUNCH OF THE "SAN FRANCISCO."

The *San Francisco* was successfully launched from a yard of the Union Iron Works in San Francisco, October 26. This ship is the second one built for the Government in that yard, the *Charleston* having been the first. The contract was let in July, 1887, the construction of the vessel having been authorized by the act of March, 1887. This ship and the *Philadelphia*, which is building at the Cramp Yards in Philadelphia, are sister ships, and the contracts were let at the same time, the price for the *Philadelphia* being $1,350,000 and for the *San Francisco*, $1,428,000. This ship is a twin-screw cruiser 328 ft. long over all; 310 ft. on water line; 49½ ft. in breadth; 31 ft. 8 in. depth; 18 ft. mean draft, and her displacement when completed will be about 4,100 tons. The vessel is not armored, but carries a heavy protective deck just above the water line, and the machinery is further protected by the arrangement of the coal-bunkers. The engines are triple-expansion, with cylinders 42 in., 60 in. and 94 in. in diameter and 42 in. stroke. The boilers, 15 ft. diameter, will carry a working pressure of 135 lbs. The two screws are three-bladed and 14½ ft. in diameter. The engines are expected to develop 7,500 H.P. under natural draft and 9,000 H. P. under forced draft, and the maximum speed is to be 19 knots an hour. The armament is to consist of 12 6-in. guns, with a secondary battery of small rapid-fire and machine guns.

In this connection we have reproduced the accompanying illustration—first published in the JOURNAL for July, 1887—which gives a side elevation and deck plan of the designs for this ship as prepared in the Navy Department, according to which she has been built. The *San Francisco*, the *Philadelphia*, and the *Newark* are the largest cruisers yet built for the Navy, but will be exceeded in weight, fighting power, and strength of armor by the *Maine*, the *Texas*, and the new battle-ship for which designs are now being prepared in the Navy Department.

THE LEAGUE ISLAND NAVY YARD.

The board appointed in July last to report a plan for the development of the League Island Navy Yard in the Delaware River has submitted its report. The report states that the island has an area of 923 acres, abundantly sufficient for any purpose required. It has a further great advantage that, being situated in the Delaware River, 90 miles from the sea, the salt water does not reach it, and that, while there is a variation of about 6 ft. in the tide, the water is always fresh. Moreover, it is or can be made practically beyond the reach of attack from a foreign navy.

The Board recommends that this yard should be provided with all the facilities and plans for building, equipping, and repairing naval vessels, and also considered that it is well placed for the establishment of works for constructing guns of largest size. It is so placed that supplies of all sorts, coal and iron, can be cheaply and quickly obtained and delivered at the yard. The main improvements proposed are as follows:

1. Converting a portion of the back channel into a deep and spacious reserved basin.
2. Constructing a smaller basin for building and repairs, opening into the reserved basin and also communicating with the Delaware by a channel.
3. Locating dry-docks and building slips within the two basins, with plate and bending shops conveniently placed.
4. Concentrating all the other shops and structures in the central space adjoining the smaller basin and dry-docks.
5. Building a permanent retaining wall along the entire river front.

The total basin area proposed is 156 acres. The estimate given by the Board includes the building of graving docks for constructing large vessels. The yard on these plans, the Board says, will be equal to the largest of foreign dock-yards, and will have a capacity for work greater than that of all the other navy yards combined. There will be, of course, should the plans be carried out, a hospital, barracks, foundry, storage yard for torpedo-boats, ropewalk, etc.

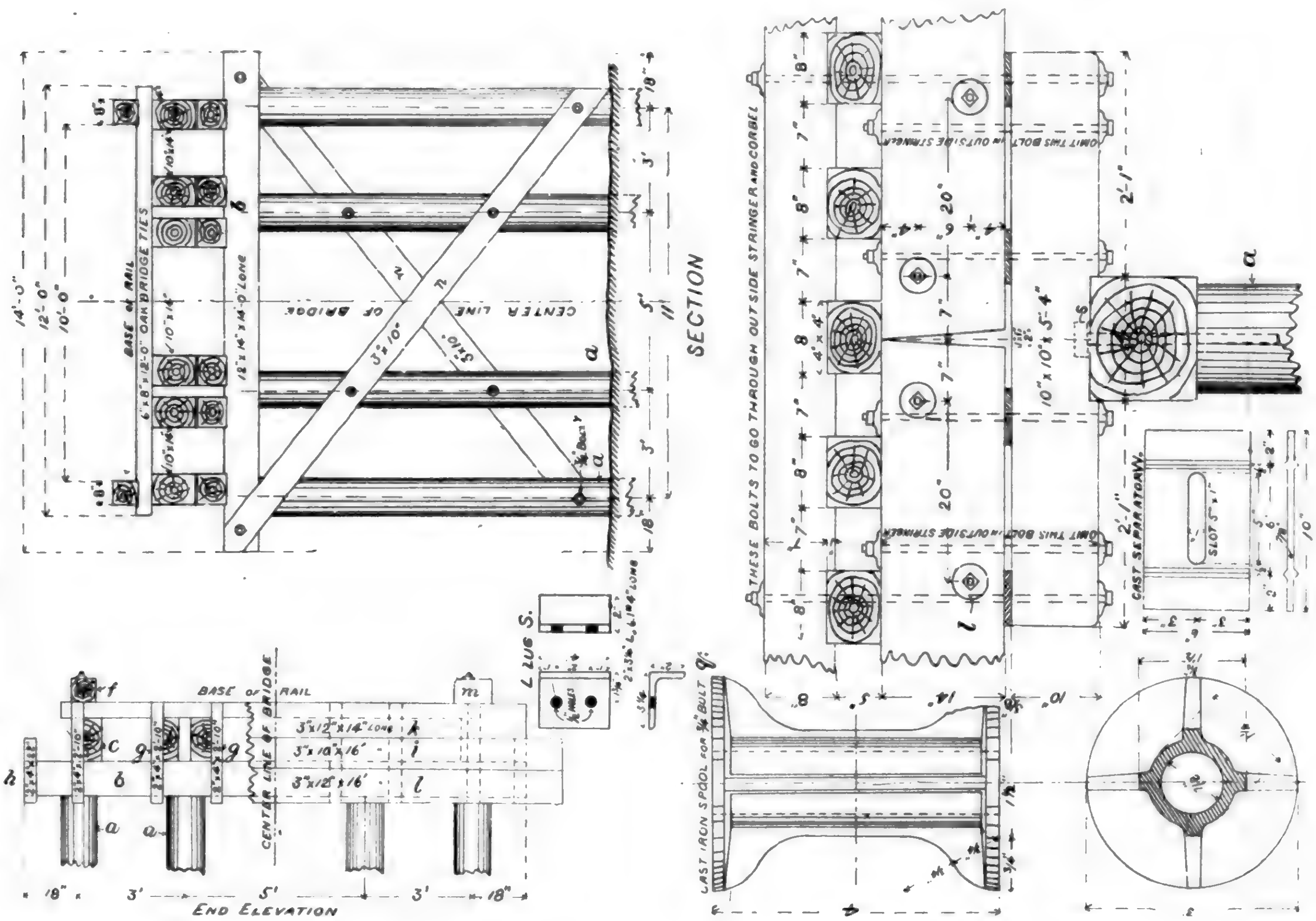
The total estimate for the complete development of the yard on this plan is $14,565,480. Of this amount $5,274,155 is required for the work to be first undertaken, the basins and docks. It is recommended that the appropriation for the first year be $1,596,000, which will give means for a proper beginning of the work on a large scale.

What action the Secretary of the Navy will take on this report is not known, and, of course, nothing can be done until Congress makes an appropriation.

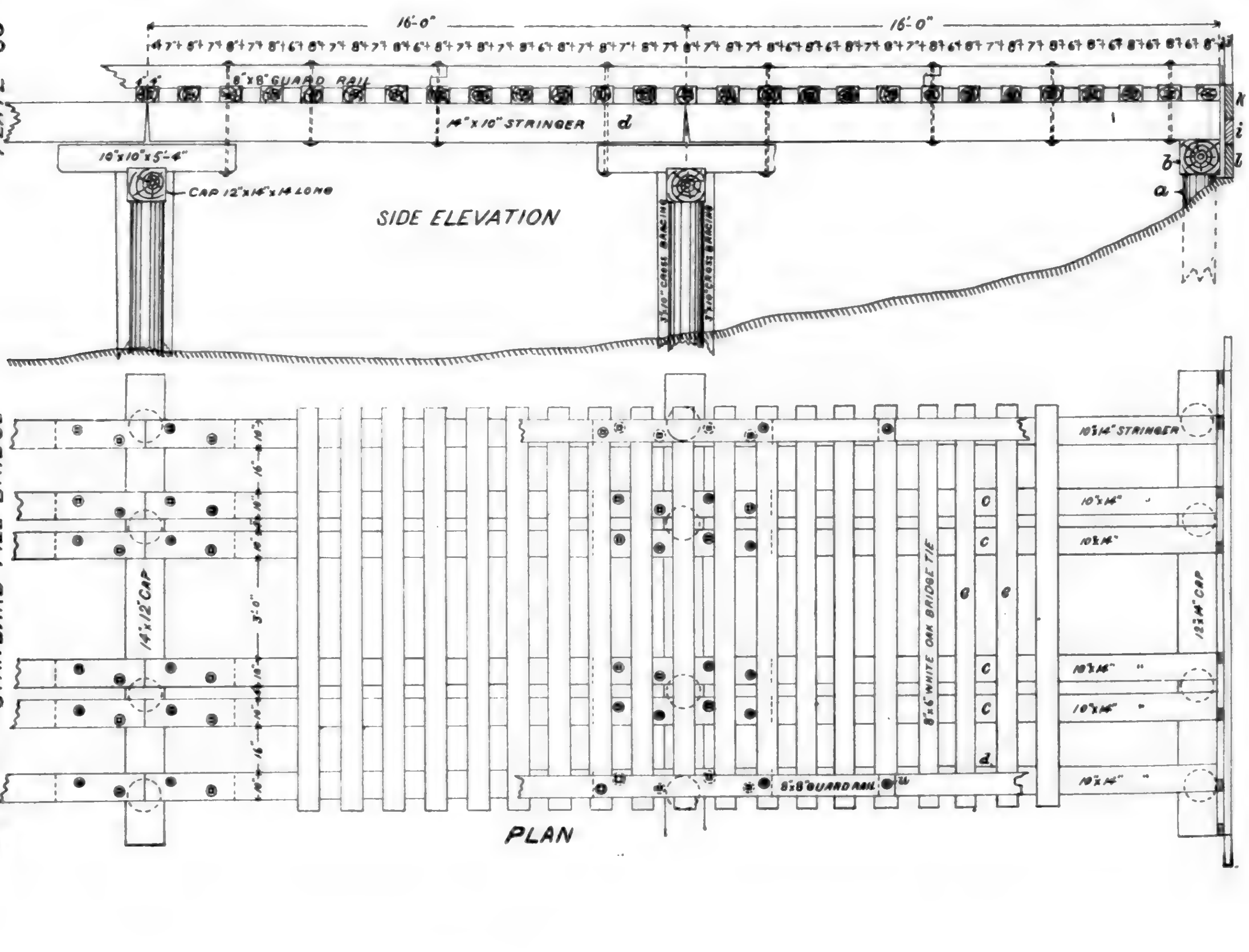
THE WASHINGTON GUN FACTORY.

The gun factory at the Washington Navy-yard is now working to its full capacity, and the machinery which was ordered some time ago is being set up as fast as received, but until it is all in place the work cannot be turned out as promptly as desired. The last guns shipped from the yard were the four 6-in. rifles for the new gunboat *Petrel*, and there are several more of the 6-in. guns nearly completed, including those for the *Bennington* and the *Concord*. Besides these guns, work is in progress on several 8-in. and 10-in. guns for the new vessels now building. Under the last appropriation of $600,000 made by Congress, a number of heavy tools were ordered, but these have not yet been delivered. Among the tools set up in the shops are some traveling cranes, the largest in the country, which were built by the Morgan Engineering Company, at Alliance, O., and some gun lathes of enor-

C. & N. W. RY. STANDARD PILE BRIDGE PLATE 61.



C. & N. W. RY. STANDARD PILE BRIDGE PLATE 60



mous size. It is expected that forgings for two 12-in. guns, the largest yet made here, will shortly be received from the Bethlehem Iron Company, but the work upon these cannot be done until the lathe ordered especially for them is received. Besides the new guns all the work on the steel projectiles is done at this yard. The rough castings are supplied from the Bethlehem and the Midvale Works and finished in Washington.

THE NAVAL WAR COLLEGE.

The Board appointed some time ago to report upon the question of consolidating the several naval establishments at Newport, has submitted its report to the Secretary of War. The recommendation made is that the Torpedo Station, the War College and the Training Station be consolidated into one establishment, to be known as the Naval School of Application, and to be under the command of an officer of high rank. At this school officers should be instructed in Naval Strategy, Naval Logistics, the Use of Naval Weapons and Equipments, and such other branches as may prepare them for actual warfare. The Board believes that in order to conduct this school successfully as many vessels as possible should be associated with it, and attached to the station as practice vessels.

As to the course of study, the Board says that the proposed school would be divided naturally into four departments: The Art of War, the Torpedo Division, the Gunnery Division, and the Apprentice Training Division. Each of these divisions should be in charge of an officer of rank and experience. The school would be under the direct charge of the Bureau of Navigation. Such buildings as are required can be erected on the Government property on Goat Island from the appropriation made by Congress. The manufacturing part of the Torpedo Station should, however, be removed to some more suitable place, if possible, as in the present location it is very liable to attack and destruction in case of war.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page 521.*)

CHAPTER XVIII.

WOODEN TRESTLE-WORK.

Originally, the word trestle was applied only to a movable frame, or set of legs connected at the top, and used for the purpose of supporting some superimposed weight. In this sense it is applied to all the different forms of frame-work used by carpenters for this purpose, such as supports for staging, trestle-horses, etc.

But in the sense in which it is used upon railroads, the word trestle has come to mean a number of legs connected at the top by a cross-piece, upon which rests a floor of sufficient strength to support the weight of passing trains. These trestles may be built of wood or iron, or a combination of both.

We will at present only consider those constructed of wood. The legs may be of any number, and cross-braced in some suitable manner to insure freedom from flexure.

A number of legs or posts connected by the same cross-piece or cap on top is called a "bent," as shown in Plate 63, Section No. 5. When these posts are framed into and rest upon a "sill" at the bottom, the bent is termed a "framed bent." In some cases the posts consist of piles driven firmly into the ground and connected at the top by a cap; such bents, to distinguish them, are called "pile bents," or pile bridges.

The use of wood in the form of trestles in railroad construction is pre-eminently an American practice. American engineers were the first to use it in this shape to any great extent, and although engineers of other nationalities have adopted wooden trestles where the environment and circumstances render them beyond a doubt desirable, still the difference in their use is just here; a French, English, or German engineer will in railroad construction never use wood in any form where it is in any way possible to procure metal or stone, and the enormous amount of expense he will incur to do away with wood in every way, is something entirely beyond the comprehension of the average American engineer. Our engineers, on the contrary, have, until the last few years, used wood in all railroad construction, where it was possible, and only used iron where it was unavoidable. This, of course, arose from the fact that iron was expensive and often difficult to procure, while wood was cheap and of most excellent quality.

Of late years, owing to the decrease in the cost of iron and steel, much less wood is used, and many wooden trestles and bridges are being replaced by iron ones. Notwithstanding this fact, however, wood in the form of culverts, trestles, and bridges is in very general use in railroad construction, and will so continue for a number of years.

This question of the use of wood in the form of trestles and bridges becomes of still greater importance to the railroad engineer from the fact that all the wooden structures put up on a road are usually designed and erected by the engineer in charge, while any elaborate piece of iron work is turned over to some expert upon the subject.

There are, of course, many evils and disadvantages connected with the use of wood in railroad construction. The two principal ones are:

1. Danger from fire.
2. Certainty of decay, involving at stated intervals complete renewals.

In the use of wood in culverts, as has been stated in Chapter V, these evils are reduced to a minimum. In box culverts the wood is buried deep in the ground, thus doing away with any danger from fire, and as, under most circumstances the wood is constantly wet, the rate of decay is very slow, and if the ordinary amount of watchfulness is used there can arise no element of danger. In time, however, the culvert must be renewed, and this renewal is generally made not in wood, but in some more durable material, such as stone-ware or iron pipes. The cost of this renewal is small compared with what the use of the same material would have been if used in the original construction, as all the facilities for transportation are present, and the whole cost is paid for out of the earnings of the road, and not by borrowed money, as is the case in the original construction.

Taking next open culverts, the disadvantages of the use of wood become more marked. They possess all the inherent evils of any opening in the track, without regard to the material used in spanning this opening. The drawbacks of these openings have already been described. Besides these there is danger from fire. The danger from decay is entirely preventable with proper care, and, therefore, will not be considered here, as it only involves a slight expense. The danger from fire, however, is one of grave importance, no matter how small or insignificant the opening may be, and also one against which the most careful watchfulness cannot secure immunity.

As we advance from open wooden culverts to trestles and bridges, the evils attending the use of wood increase also, and there is added to the danger to human life from the destruction of one of these structures, the loss and expense to the road due to the interruption of traffic caused by any break in the track that prevents the free circulation of trains.

These are, then, to repeat, the disadvantages attending the use of wood in the construction of culverts, trestles, and bridges:

1. Liability to destruction by fire, causing loss of life and interruption of traffic.
2. Certainty of decay, requiring never-ceasing watchfulness and a continual running expense for repairs and renewals.

The amount of importance that should be given to the first-mentioned evil depends upon the number of daily trains in use. The location of the structures in regard to the alignment is also to be considered— that is, culverts, trestles, or any openings in the track are much more ob-

PLATE 63

A. T. & S. F. R.R.
PILE & TRESTLE BRIDGES

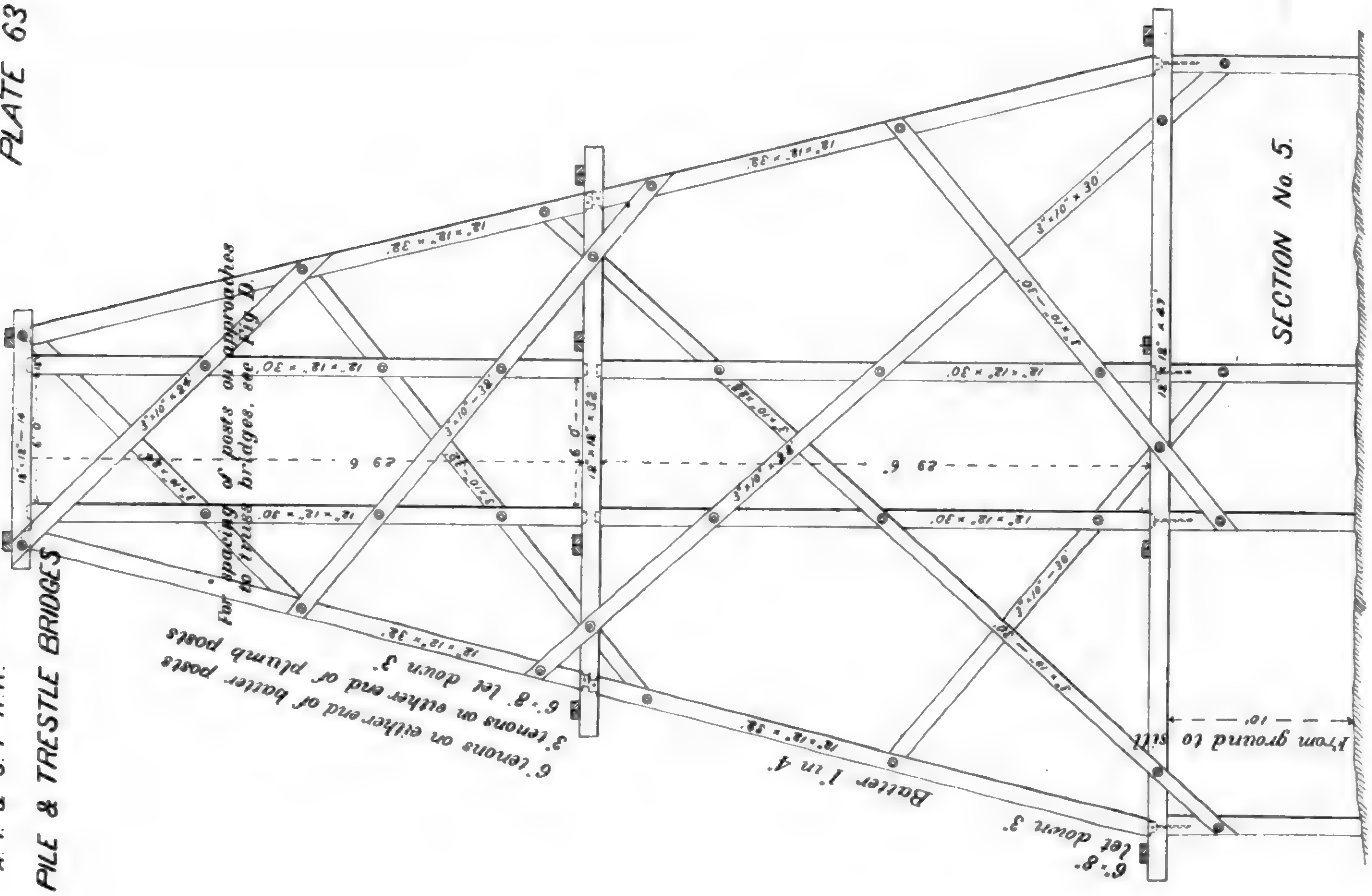
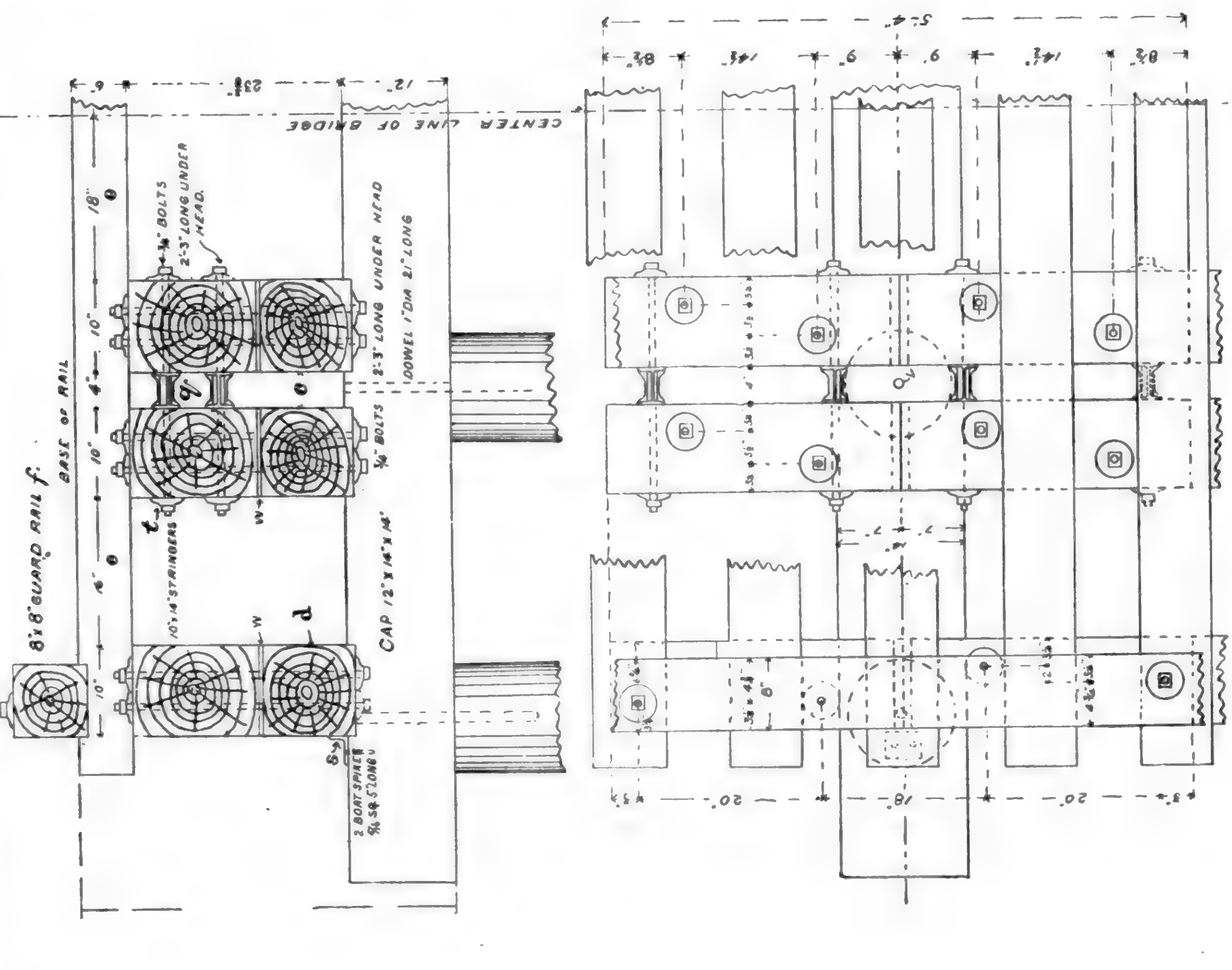
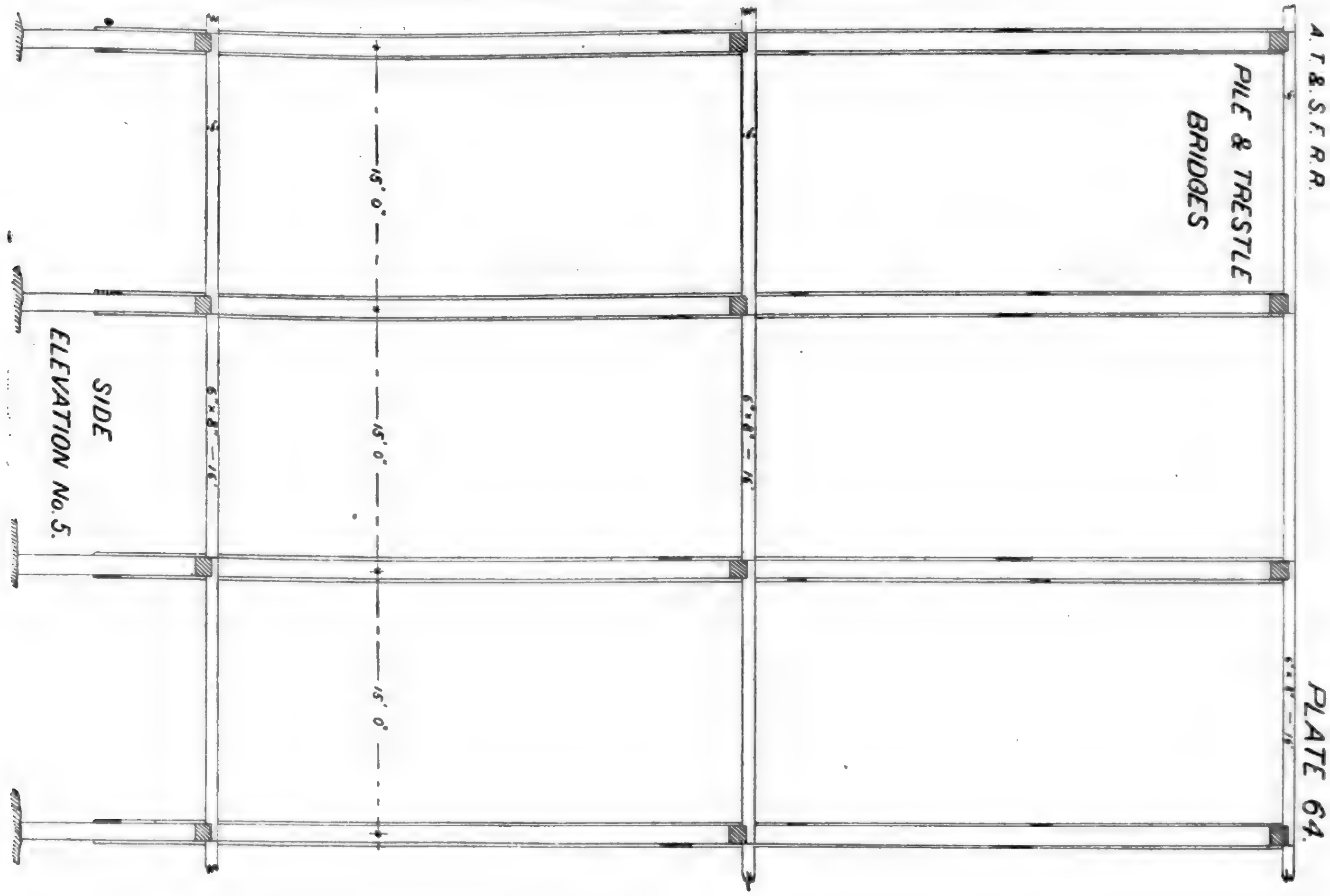
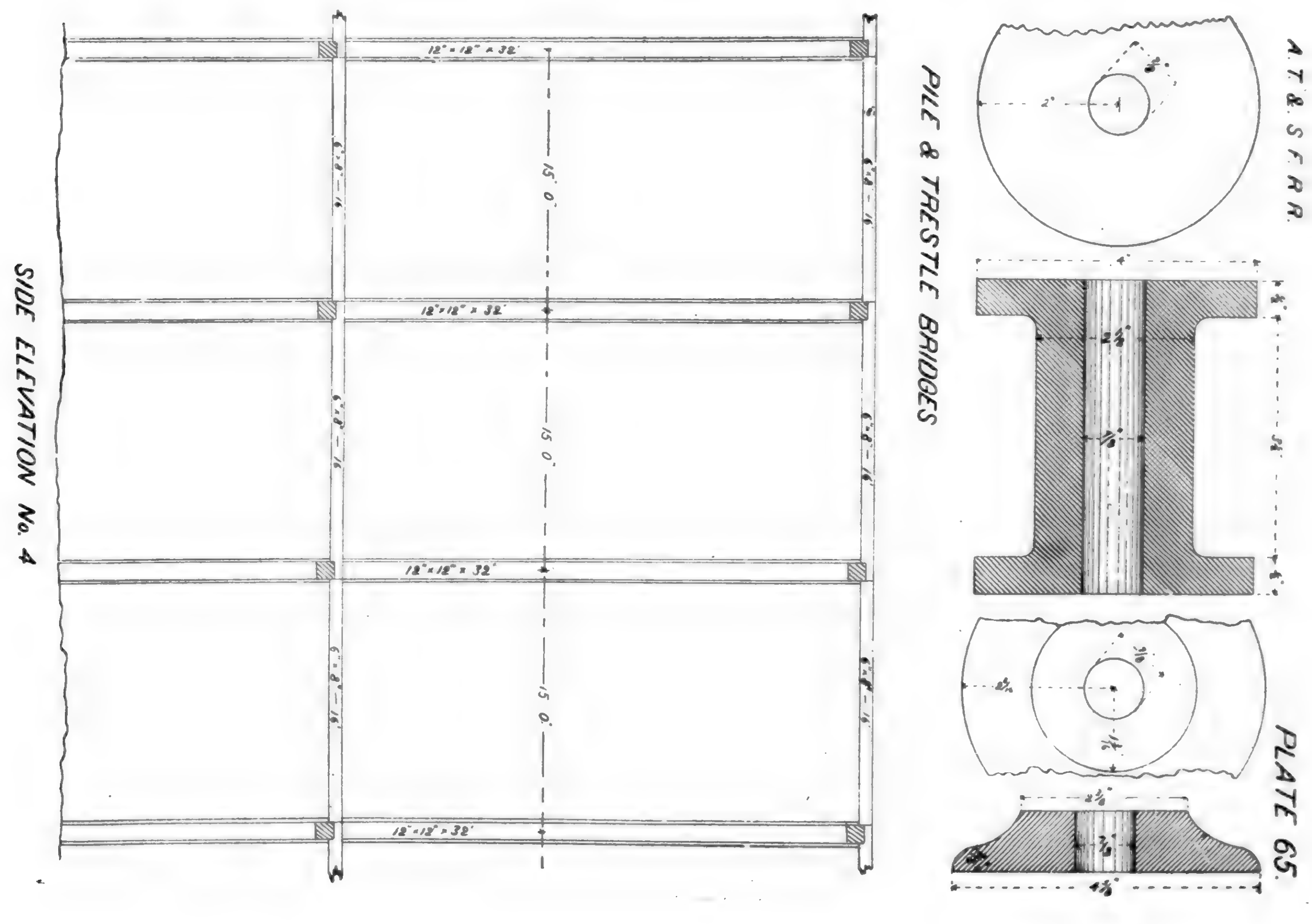


PLATE 62

C. & N.W. RY.
STANDARD PILE BRIDGE




A.T.&S.F.R.R.
PILE & TRESTLE BRIDGES
SIDE ELEVATION No. 5.
PLATE 64.
15' 0"
15' 0"
15' 0"
6"x8"—16'


A.T.&S.F.R.R.
PILE & TRESTLE BRIDGES
SIDE ELEVATION No. 4
PLATE 65.
12"x12"x32'
15' 0"
6"x8"—16'

jectionable when situated upon a curve, or in such a position that they are not clearly visible from approaching trains. The methods of administration of the Road Department are of importance, as affecting the amount of watchfulness that under all circumstances will be kept.

The amount of traffic the road has is a very decided element in any question as to whether wood or iron shall be used. It is not entirely a question of whether the road can afford to incur the additional expense of iron structures. A road with no surplus revenue, but doing a large business, could well afford to borrow at a high rate of interest the money necessary, rather than even to run the chances of having its line blocked for a single day, while another road, with plenty of money, but running comparatively few trains, would probably find it economical to take the chances and use wood, if less expensive. The whole of this question in reference to possible interruption of traffic and loss of life is one in regard to which no fixed rules can be laid down, but one that must be decided in each case to the best of the ability of the persons in charge.

In regard, however, to the second disadvantage attending the use of wood—viz., the expense of repairs and renewals, the case is entirely different.

For the first few years this expense is very light, but increasing each year, and never ending. The probable amount of this expense can be very easily calculated for each individual road and for each structure. Then this amount of yearly expense for repairs and renewals, made necessary because the structure is of wood and not of iron, will be the interest upon the amount of money that can be economically spent to put in iron-work. To this amount should be added the amount at which possible exemption from accident, from fire, etc., has been calculated.

In regard to the details of construction, the following plates, commencing with No. 60, show some of the best examples of standard pile and trestle bridges, as used by the various roads in this country.*

As will be seen by an examination of the plates, the general plans of the bents are more or less the same, and consist of two vertical posts, one under each rail, and two batter posts, one on each side, as shown in the plates. The tops of the batter posts are from two to three feet outside of the vertical or "plumb posts." The amount of batter or inclination given to the batter posts varies upon each road, to some extent, and depends also upon the class and character of the foundation. The more unstable the foundation the greater should be the spread of the bent at the bottom. The amount used in ordinary work runs from 0 to an inclination of 1 in. horizontal to 4 in. vertical.

In the case of pile bents, as shown in Plate 66, there is no inclination given to any of the posts. This method could only be used up to about 24 ft., with four piles, but by driving a center pile, making five in a bent, the height can be increased to over 30 ft.

Whenever this form of bent is used, however, much care must be taken to use sufficient diagonal bracing, as there is a great tendency to a sidewise movement of the top, especially if the trestle should be on a curve.

The caps are usually 12 in. × 12 in., or 12 in. × 14 in. timber, and of sufficient length to allow the diagonal bracing to be bolted to the ends beyond the batter post. The cap may be in one piece 12 in. × 12 in., or in two pieces, called a split-cap, 6 in. × 12 in. each. It is fastened to the posts in a variety of ways that are discussed later.

In framed bents the lower end of the posts rests upon a sill usually about 12 in. × 12 in., or the same size as the cap. This sill rests upon a firm, solid foundation, either natural or artificial.

Where the ground is firm, and there is no danger from water, the sill very often rests upon cross-sills (called mud-sills) that are imbedded in the ground. These mud-sills are timbers about 12 in. wide, and from 4 in. to 12 in. thick. The top soil is cleared away, and a uniform bed made for them to rest upon. They run at right angles to the face of the bent, and there should be one under each of the posts resting on the sill.

* The Author wishes to return thanks to the Chief Engineers of the various railroads, to whose kindness he is indebted for blue-prints from which these drawings were made, and for many other points of information embodied in these articles.

Where the ground is less firm, a trench for each mud-sill can be excavated to some depth below the bottom of the mud-sill, and then filled to the required height with sand well packed in layers. If the nature of the ground be such that there is no possibility of the sand spreading laterally, no better foundation can be had.

In some cases these trenches are filled with broken stone, upon which the mud-sills rest, while in other cases the mud-sill is done away with entirely, and a small masonry pier is built, upon which rests the sill of the bents.

In using any one of these arrangements for supporting the sill upon a firm foundation, care should be used that the sill is raised clear from the ground. When the ground is very soft and yielding, the most economical, and by far the most generally used method of securing a firm foundation, is by driving piles and sawing them off at any required height above the ground. The sill rests upon these piles, and is usually bolted to them by ¾-in. drift-bolts.

The diagonal bracing is bolted to each post, and to the ends of the cap and sill by ¾-in. bolts, with head, nut and thread. The details of the caps, chords, floor system, etc., will be taken up in the next chapter. The distance between the bents in the direction of the track is governed, to a great extent, by the height of the bents.

There may be local circumstances that decide this distance, but everything else being equal, the higher the bent the greater should be the distance between them, in order to obtain the most economical trestle.

No. 34. Bill of Material for Pile Bridge, Chicago & North-western Railway.—Plates 60, 61, 62. Material for One-Span Pile Bridge.

No. Pcs.	Description.	Mark.	Length.
8	Piles, 12 in. diam.	*a*	
2	Caps, 12" × 14"	*b*	14'—0"
4	Track Stringers, 10" × 14"	*c*	16'—0"
2	Outside Stringers, 10" × 14"	*d*	16'—0"
14	6" × 8" Oak Bridge Ties	*e*	12'—0"
2	8" × 8" Guard Rails	*f*	16'—0"
12	2" × 4"	*g*	2'—10"
4	2" × 4"	*h*	1'—10"
2	3" × 10"	*i*	16'—0"
2	3" × 12"	*k*	14'—0"
2	3" × 12"	*l*	16'—0"
2	Number Boards, 8" × 1⅛"	*m*	1'—0"
	Iron.		
8	Dowels, 1" diam.	*v*	1'—9"
8	Bolts ¾" diam. 2" thread	*r*	2'—3" under head.
4	2" × 3¼ L's, 6.1 lbs.	*s*	4"
32	Cast Washers	*t*	
8	Bolts ¾" diam., 2" thread	*u*	2'—5¾" under head.
8	Cast Spools	*q*	
8	Pounds, 30 d Spikes		

Add for Two-Span Pile Bridge.

No. Pcs.	Description.	Mark.	Length.
4	Piles, 12" diam	*a*	
1	Cap, 12" × 14"	*b*	14'—0"
4	Track Stringers, 10" × 14"	*c*	16'—0"
2	Outside Stringers, 10" × 14"	*d*	16'—0"
13	6" × 8" Oak Bridge Ties	*e*	12'—0"
4	8" × 8" Guard Rails	*f*	9'—0"
2	3" × 10" Cross Bracing	*n*	
6	Corbels, 10" × 10"	*o*	5'—4"
	Iron.		
4	Dowels, 1" diam	*v*	1'—9"
28	Bolts, ¾" diam., 2" thread	*r*	2'—3" under head.
2	2" × 3¼" L's, 6.1 lbs.	*s*	4"
88	Cast Washers	*t*	
4	¾" Bolts, 2" thread.	*u*	2'—5¾" under head.
8	Cast Spools	*q*	
24	Cast Separators.	*w*	
4	Bolts, ¾" diam., 2" thread	*x*	4'—2" under head.
8	Bolts, ¾" diam., 3½" thread	*y*	19¾" under head.
6	Boat Spikes, 5-16" square	*z*	5"

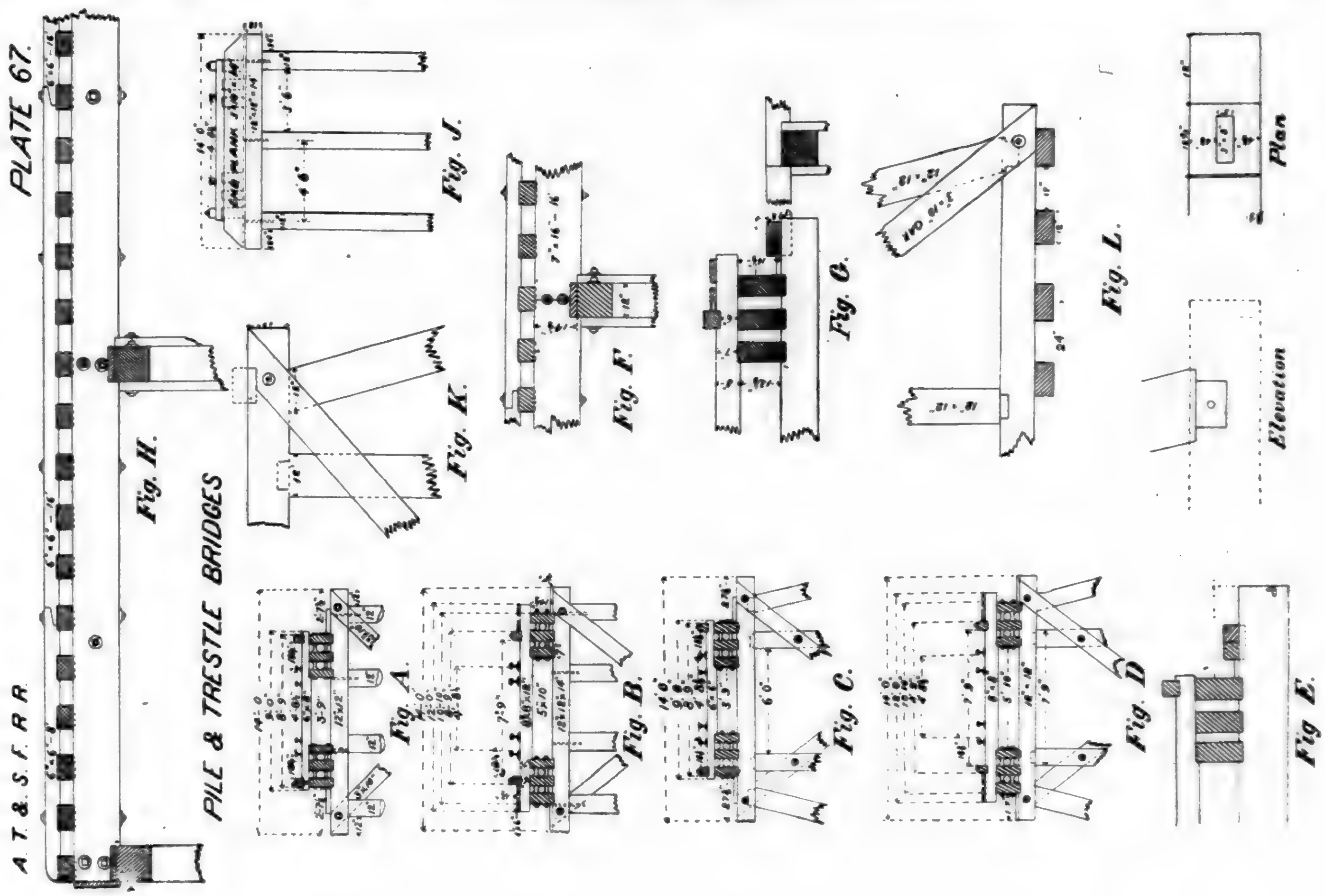


PLATE 67.
A.T. & S.F. R.R.
PILE & TRESTLE BRIDGES
Fig. H.
Fig. J.
Fig. K.
Fig. F.
Fig. G.
Fig. L.
Plan
Elevation
Fig. A.
Fig. B.
Fig. C.
Fig. D.
Fig. E.

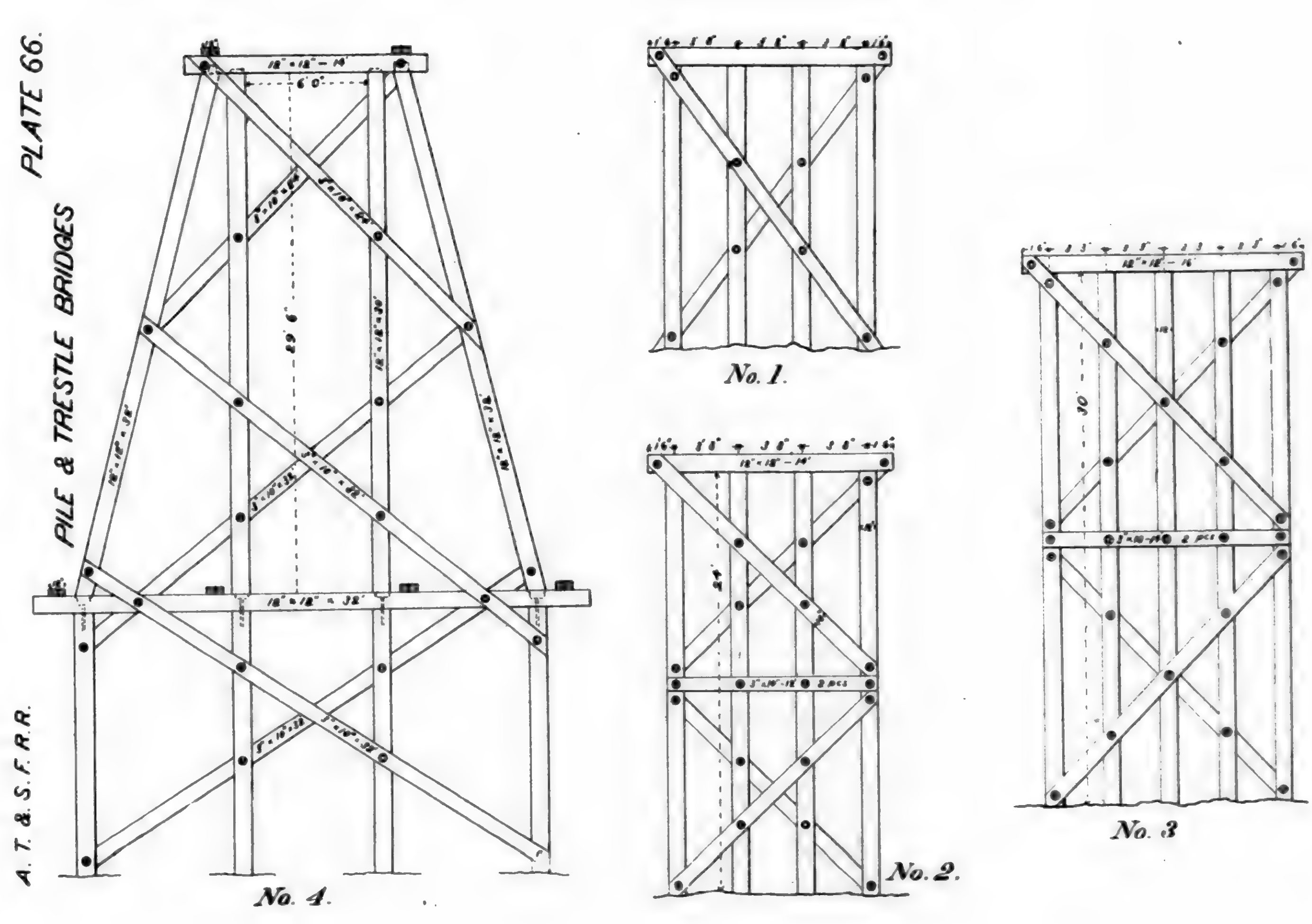


PLATE 66.
A.T. & S.F. R.R.
PILE & TRESTLE BRIDGES
No. 1.
No. 2.
No. 3
No. 4.

ADD FOR EACH SUCCESSIVE SPAN.

No. Pcs.	Description.	Mark.	Length.
4	Piles, 12" diam.	a	
1	Cap, 12" × 14"	b	14′—0"
4	Track Stringers, 10" × 14"	c	16′—0"
2	Outside Stringers, 10" × 14"	d	16′—0"
12	6" × 8" Oak Bridge Ties	e	12′—0"
2	8" × 8" Guard Rail	f	16′—0" for every odd span.
2	3" × 10" Cross Bracing	p	
6	10" × 10" Corbels	u	5′—4"
2	8" × 8" Guard Rails	f	18′—0" for every even span.
	IRON.		
4	Dowels, 1" diam.	v	1′—9"
28	Bolts, ⅝" diam., 2" thread	r	2′—3" under head.
2	2" × 3¼" L's, 6.1 lbs.	s	4"
88	Cast Washers	t	
4	Bolts, ¾" diam., 2" thread	u	2′—5¾" under head.
8	Cast Spools	q	
24	Cast Separators	w	
4	Bolts, ⅝" diam., 2" thread	x	4′—2" under head.
8	Bolts, ¾" diam., 3½" thread	y	1′—7¾" under head.
6	Boat Spikes, 5-16" square	z	5"

The cost of the bents increases with their height (but not in the same ratio), so that the more the bent costs the more expense can be economically incurred to reduce the number of the bents. This can be calculated in any particular case.

The ordinary distance between bents from 10 to 25 ft. in height is 12 to 15 ft., the openings being spanned by chords not braced at all. As the height increases the spans may be made longer and the chords braced. This is carried on until at last we have a regular truss bridge supported at each end upon a bent, or cluster of bents.

Up to a certain height, one row of four posts is sufficient, but beyond that point the number in the row must be increased by one or two, or the bents so arranged in clusters as to permit of proper longitudinal bracing.

One thing that has led to such a general use of wooden trestles in this country is the principle upon which all our railroads are built—viz., to build as rapidly as possible, and with as little expenditure of money in the first case as is consistent with ordinary safety and economy in the future operation.

This principle has led to the trestling of high fills when either earth or time were limited, with the idea of filling in afterward with earth.

As to what height embankment is cheaper than wooden trestle, nothing can be fixed, as local circumstances govern the question in every case.

In regard to actual first cost, taking labor and material at ordinary rates, a trestle 35 ft. high costs about one-half as much as an embankment the same height– the earth being conveniently located and the lumber at ordinary rates.

To this difference, however, must be added either the cost of repairs and renewal of the trestle, or the cost of filling in with earth in the future.

By means of the great improvements that have been made of late years in the mechanical devices for handling earth both in loading and unloading, in the shape of steam shovels and excavators and automatic unloading devices, the cost of filling in the future has been very much reduced.

Some further examples of trestle bridges, with bills of material, etc., will be given in the next number.

(TO BE CONTINUED.)

PENNSYLVANIA CANALS.

THE Commission appointed by the Governor of Pennsylvania to investigate the question of building a ship-canal to connect Lake Erie and the Ohio River has organized by electing Captain John A. Wood, of Pittsburgh, President; W. S. Shallenberger, of Rochester, Treasurer; Eben Brewer, of Erie, Secretary. To fill the vacancy caused by the resignation of Reuben Miller, the Governor has appointed as a member of the Commission, Thomas P. Roberts, of Pittsburgh, Chief Engineer of the Monongahela Navigation Company. The two engineers, who are members of the Commission—John M. Goodwin and Thomas P. Roberts—will direct the surveys which will be made.

The appointment of this Commission was authorized by the Pennsylvania Legislature at its last session, and at the same time a sum of $10,000 was appropriated to pay the necessary expenses. The work to be done is to gather information as to the possibility of building a ship-canal to connect the waters of the Ohio River with Lake Erie, this information to be submitted to the Legislature as a basis for further action on the part of the State. The members of the Commission will begin their work by making a trip over the lines proposed for the canal, and probably more complete surveys will be undertaken.

The only plan submitted, so far, has been one prepared by Mr. G. L. Moody, of Erie, who proposed to make available for the canal three drainage basins, the Chautauqua on the east, the Oil Creek on the south, and the Conneaut or French Creek Basin on the west. From the last-named basin the water for the old Beaver & Erie Canal was drawn. The water from the three basins would be led by feeders to Conneaut Lake, which would be made the reservoir or supply basin for the summit level of the canal. Other engineers are inclined to think that this plan is somewhat too extensive, and that it will not be necessary to draw upon all three drainage basins to supply the water. The whole matter, however, will be carefully considered by the Commission, which includes among its members two able engineers, both of whom are familiar with canal work, and are also well acquainted with the region through which this canal is to pass. The proposed work is one of great importance to the coal and iron interests of Pittsburgh and Western Pennsylvania.

While the State is thus planning a new canal or connection for the West, it has been definitely decided to abandon the old Pennsylvania Canal, which has been in operation for so many years east of the Alleghenies. As has been heretofore noted, the canal from Huntingdon eastward was practically destroyed by the floods of last June, and the expense of repairing, or rather of rebuilding it, was apparently too great to be undertaken, in view of the small business now done by the canal, most of the traffic of which has passed to the railroads. The Pennsylvania Railroad Company, which has controlled it for a number of years, is now having surveys made of portions of it, with a view of using the canal-bed for new tracks for its line, and in the mean time, a number of the dams which were built to make reservoirs for the supply of water to the canal have been destroyed, in order to leave free passage for the water of the Juniata River in case of another freshet.

IRRIGATION IN EGYPT.

[Condensed from paper read by Mr. Cope Whitehouse, C.E., before the Western Society of Engineers.]

STARTLING as has been the advance of the Western world in rapid transit of persons, merchandise, and thought, the use made of water falling from the mountains to the sea shows no corresponding progress. The engineering works which here and there regulate the flow of a stream in the United States are contemptible in view of what remains to be done, and, with scant exception, are below the level of even the minor modern constructions to be found among those Oriental nations whom the American engineer has been often taught to despise. It has been an essential feature of that modern philosophy, which is popularly associated with the name of Darwin, that development is an attribute of time. The mechanical engineer, in the presence of such stupendous triumphs as the ocean steamer, or the vast spans of many a bridge, may fearlessly challenge the past. It is nevertheless true that the unbridled career of our rivers, great and small, exhibits a barbarism so primitive that the founder of the Chinese Empire, who restrained the Hoang-Ho; or Menas, who established civilization in Memphis, building the city upon ground laid bare by the diversion of the Nile, would stand

aghast at the sharp contrast offered by advancement in the use of steam, steel, and electricity, with the utter neglect of that immense force that represented to the rulers of the East so obviously, individual welfare and national empire. Those lords of the Nile would despise us as slaves of the Colorado and the Mississippi, contented to submit with supine tameness to the caprices of our water-courses, as if these rivers were not as amenable to control as the drainage basins of the Abyssinian mountains and the lakes of Central Africa. These questions of irrigation, drainage, and river transportation are hourly assuming greater importance. They have attracted the attention of the American people. They are being carefully studied. The problems will be solved and the difficulties surmounted by that energy and febrile ingenuity which are characteristic of our country. It cannot but prove interesting and instructive to examine irrigation in Egypt, dependent upon that anomalous river which so long ago exercised human thought, and continues to this day to present the same conflict between nature and man.

At the commencement of this century French engineers succeeded, in supreme control, the Pharaohs, the Persians, the Greeks, and the Arabs. Now the ultimate direction is in the hands of about ten British officials trained in India. The native division-engineers, however, are men of great local knowledge and practical as well as technical ability. Ali Pasha Mubarekh, now Minister of Public Instruction, was formerly Minister of Public Works. He is a conspicuous example of success in amassing singularly vast stores of profound and varied knowledge on all subjects connected with the engineering profession.

The current idea of the topography of Egypt is erroneous in the extreme. It is not a sandy plain traversed by a river, whose inundation brings fertility to the farthest parts reached by the life-giving stream. The pyramids are neither in the river, as Shakespeare says, nor in a sea of sand, as Dr. Brugsch describes them. The Nile Valley to the south of Cairo, is sharply distinguished from the Delta. The Nile itself is practically a double stream. The perennial flow is maintained from the great lakes of Equatorial Africa ; the inundation is due to the rain-fall on the Abyssinian mountains. The supply from the end of February, for about three months, is insufficient for the area under actual cultivation. This is little more than one-half the extent cultivated under the Pharaohs or the Ptolemies. The entire area of cultivated land is artificially irrigated. The inundation of Middle Egypt is everywhere controlled by embankments many thousand miles in extent. In Upper Egypt as soon as the water rises out of its deep channel, it is allowed to flow into districts of 50,000 to 80,000 acres. Should it afterward rise higher it is excluded from these shallow pools, where the fertilizing alluvium is deposited, while the villages, with their palm-groves, rise above the water like islands, each secured by its own wall of earth, strengthened by brick. The high Nile thus becomes a menace. Its flood is forced into a comparatively narrow channel, whose bounds it not infrequently bursts.

In the Delta the inundation is wholly excluded whenever such summer crops as cotton, sugar-cane, and rice are growing. Canals supply enough water for the crops. Scarcely one-twentieth of the whole discharge in flood is utilized.

The missing factor in Egyptian prosperity is the great lake Moeris, described by the ancient historians and depicted upon their maps. The Author's discovery of the Raijan Valley, which formed part of this reservoir, offers a means of controlling the flood waters of the Nile, and storing a sufficient portion of its surplus to double the discharge of the river during the annual drought. All the facts have been verified by the Egyptian Government, and reports have been made, based upon the official surveys by Sir C. C. Scott-Moncrieff, Author of the well-known book on Irrigation, Under-Secretary of State for Public Works ; Colonel Western, the Director-General of Works ; Colonel Ross, Inspector-General of Irrigation ; Sir Edgar Vincent, late Financial Adviser to the Khedive ; Nubar Pasha, late President of the Council ; Colonel Ardagh, late Chief of Staff in the Army of Occupation, and many others. Lord Salisbury, Sir J. Ferguson, and Sir Evelyn Baring have attested the accuracy of these reports and have conceded the enormous benefits which would accrue to Egypt from the execution of the proposed canal. The Khedive, with his strong love for the people under his care, has always manifested an appreciative sympathy for my investigations.

The Raijan project is briefly a scheme to put the Nile in communication with a depression, 250 square miles in area, in the desert to the west of the Nile and about 75 miles south of Cairo. Its circuit of 230 miles is bounded by plateaus of horizontal limestone, after rising to a height of 600 ft. Its soil is desert sand overlying rock and yellow clay. About one-tenth of the area is occupied by steep ridges of blown sand, 60 ft. high. It contains no inhabitants. To the south are two springs, warm and sulphurous, with a few date-palms and a little coarse vegetation. Its greatest depth is 153 ft. below the Mediterranean, or about 250 ft. below high Nile in the adjacent valley. It can be readily utilized to relieve the Nile during flood, assist the drainage of Middle and Lower Egypt, and store water for summer use from April to July.

The shortest and most direct channel through the Berek-Abu-Hamed hill is six miles in length. This involves a tunnel or a cutting, with a maximum depth of 160 ft. A longer, but in many respects easier route by the Myana Pass is that which has been most fully considered. It has been surveyed with great care and thoroughness. It requires the handling of about 3,500,000 cubic yards of sand, clay, and soft rock, with an average delivery of the material at 20 ft. above the excavation. The same channel, with a regulator and flood-gates, will be used for both the intake and outflow. The reservoir thus formed would contain about 20,500 million cubic meters, or, say, 5,000,000 million gallons. The average rise of the Nile is about 25 ft. The stratum of water available without pumping would be 250 square miles by 25 ft., less evaporation and loss of head. This would yield an average annual supply of about 5,000 million cubic meters, or, say, 1,250,000 million gallons—equal to a daily delivery of 12,000 million gallons during the season of low Nile. The present minimum supply on which the whole export crop of Egypt depends—its cotton, rice, and sugar cane—is about 20 million cubic meters per diem, or less than one-half the amount which could be profitably employed. The Raijan reservoir would more than double the normal flow of the river at this season. The water is now economized in Upper and Middle Egypt as well as in the Delta. The demand for an increased quantity is immediate and pressing. On the completion of the system of Barrage canals it will require an increase of two-thirds of the present supply to cultivate the land which will be offered for summer cultivation. The total possible increased area of cultivated land has been officially put at 3,000,000 acres. The total volume of Egyptian produce would probably be nearly doubled. Sanitary questions have their economical aspect. The death-rate now rises to 92 per 1,000—yet Alexandria was reputed in the Roman days to be the healthiest city on the Mediterranean, while the neighborhood of Cairo and Memphis was famed for its salubrity. The preservation from disaster is a material consideration. The loss by the excessive inundation has reached $5,000,000, while the insufficient Nile last year was officially declared to have cost $1,500,000.

It may therefore be safely stated that a reservoir and canal of escape can be constructed for $2,500,000. It would not require more than one year to make the canal, and probably three inundations would suffice to fill the basin without prejudice to the interests of the present cultivated area. This represents an addition to the wealth of Egypt of not less than $5,000,000 per annum.

At the conclusion of the paper, Mr. Whitehouse was questioned as to the geology of the Nile and the basin he had discovered, to which he replied at length, stating that no satisfactory explanation had been afforded of the origin of the basin. He also further explained some of the physical conditions of the Nile.

Being asked as to any financial plan having been devised for carrying out the works, he stated that the money could be obtained without difficulty, but the impediments to immediate work were personal ones, in that an American layman had made the discovery and had pushed the enterprise in the face of a large array of engineering talent and official control.

THE PENCOYD STEAM HAMMER.

THE accompanying illustrations show a large hammer which has recently been erected and put in use at the Pencoyd Iron Works of A. & P. Roberts, at Pencoyd, near Philadelphia. The large engraving is taken from a photograph, showing the hammer, with the heating furnaces, cranes, etc. This hammer is used for drawing down and forging steel ingots, and is of unusually large size and solid construction. It was built by the Markische Maschinenbau Anstatt, at Wetter, Westphalen, but the cranes and appliances were made in the Pencoyd shops. It is a single-acting hammer, steam being used only under the piston to lift the hammer-head, and the blow being struck by the force of gravity alone. The hammer-head and moving parts weigh in round numbers 40,000 lbs. The diameter of the cylinder is 1.100 m. (43.3 in.), and the stroke is 2.500 m. (8 ft. 2.4 in.)

The foundation of this hammer was made by excavating the ground to the bed-rock, a depth of about 14 ft. below the floor level of the hammer-shop. Upon this was built a bed of cut stone masonry, upon which the foundation proper of the hammer rests. This consists, in the first place, of two layers of white oak timbers 9 × 12 in. in size, and about 16 ft. long, each layer being bolted together, and the two being laid, as is usually the case with such foundations, in opposite directions. On top of these timbers is placed the cast-iron anvil-block, which weighs in all about 210,000 lbs. This anvil-block is made in four pieces, the bottom or base-plate being 11 ft. 10 in. × 15 ft. 10 in. in size and 21¾ in. thick. The second piece or block is 27½ in. thick, the third 36½, and the fourth 42 in. in thickness, each block being somewhat smaller in surface than the one below. The general form of the anvil-block is that of a truncated pyramid. The different blocks composing it are held together by keys, and after they were in place soft metal (zinc) was poured in, filling all the cracks and interstices between them. On top of the upper cast-iron block is placed the steel anvil-block or die upon which the hammer blow is received. The total height of the foundation from the top of the masonry to the face of the die is 13 ft. 4 in., and the die stands about 2 ft. 6 in. above the floor of the hammer-shop.

The main frame of the hammer consists, as will be seen from the engraving, of two circular columns, built up of wrought-iron plates and angles, supporting a cross-girder, which serves as a platform to sustain the hammer. These wrought-iron columns are 2.850 m. (7 ft. 9½ in.) in height, and vary in diameter from 1.575 m. (5 ft. 2 in.) at the base to 1.318 m. (4 ft. 4 in.) at the top. They rest at the bottom on heavy cast-iron base-plates 6 × 8 ft. in size, placed upon a stone foundation, to which each base-plate is secured by six heavy foundation-bolts passing through the masonry. These base-plates and their foundations are entirely independent of the anvil-block.

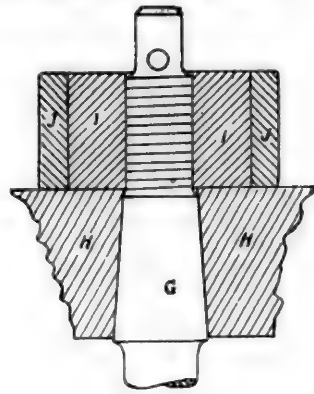
The box-girder upon which the hammer rests, is, as before noted, built up of plates and angles. The general form will be readily seen from the engraving. It is 0.942 m. (37.1 in.) in depth, 1.500 m. (59.1 in.) wide, and 7.580 m. (25 ft. 9 in.) long over all. The centers of the pillars are 6.280 m. (27 ft. 7 in.) apart. The girder is open in the center to permit the passage of the hammer-head. Supported on this cross-girder, and secured to it by heavy bolts, are two upright frames of cast-iron; the form of these is shown in the engraving. These cast-iron frames are 2.983 m. (9 ft. 9.5 in.) in height, and carry at the top the entablature, which is also of cast-iron and is a plate 0.616 m. (24.2 in.) in thickness, serving both to connect the frames at the top and also to carry the cylinder. The latter rests upon the entablature; it is 3.020 m. (9 ft. 10.9 in.) in total height.

The general arrangement of the lower frame is such as to give abundant room for handling very large pieces upon the anvil. The clear space between the columns is about 15½ ft. and the hammer-man can work in almost any direction

The guides are separate from the frame and are bolted to the face of the cast-iron frames. They are in all 12 ft. 6 in. long, and extend some distance below the cross-girder of the lower frame, being supported on either side below by cast-iron brackets bolted to the under side of the girder as shown. The ram of the hammer is 2.275 m. (7 ft. 5.5 in.) in length and about 3 ft. 3 in. square in section. It is recessed on either side for the guides, which are single.

The depth of the ram given above does not include the die or steel head, which is keyed upon its lower face, and which is 0.470 m. (18½ in.) in depth. The piston-rod is secured to the hammer-head in the manner shown in the accompanying sketch, fig. 2. In this figure, *G* is the piston-rod; *A A* is a split steel ring tapered to fit the taper on the end of the rod; *B B* is a second steel ring; *C* is a copper plate, and *D D* is a number of thin iron plates. The object of this arrangement is to provide a bed having some elasticity to take up part of the shock. Above the ring, *A A*, two keys, *E E*, pass through the hammer-head and secure the piston-rod in its place.

The method of securing the upper end of the rod to the piston is shown in the same sketch, fig. 1. In this *H H* is the body of the piston; *G* the rod; *I I* a circular split nut,



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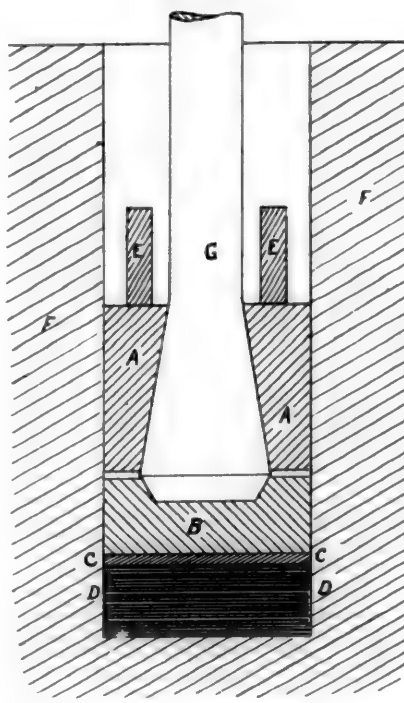

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The cylinder, as before noted, is 1.100 m. (43.3 in.) in diameter. It is bolted to the entablature by the flange at its lower end, and carries at one side a circular steam-chest through which steam is admitted. This steam-chest contains the valves, which are plain circular valves, of what is often called the Cornish pattern—round valves with flat seats. The steam-pipe is attached directly to the side of the valve-chest as shown. The exhaust passage is cast in the entablature, and the exhaust steam passes out from the bottom of the cylinder. The valves are worked from below by means of a rod and hand lever, placed conveniently for the hammerman.

TWENTY-TON STEAM HAMMER AT THE PENCOYD IRON WORKS.

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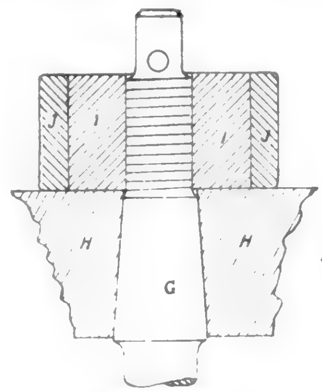
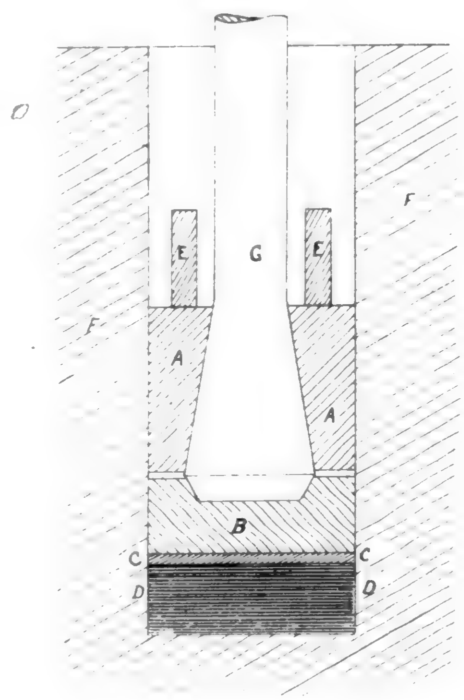


Fig 1



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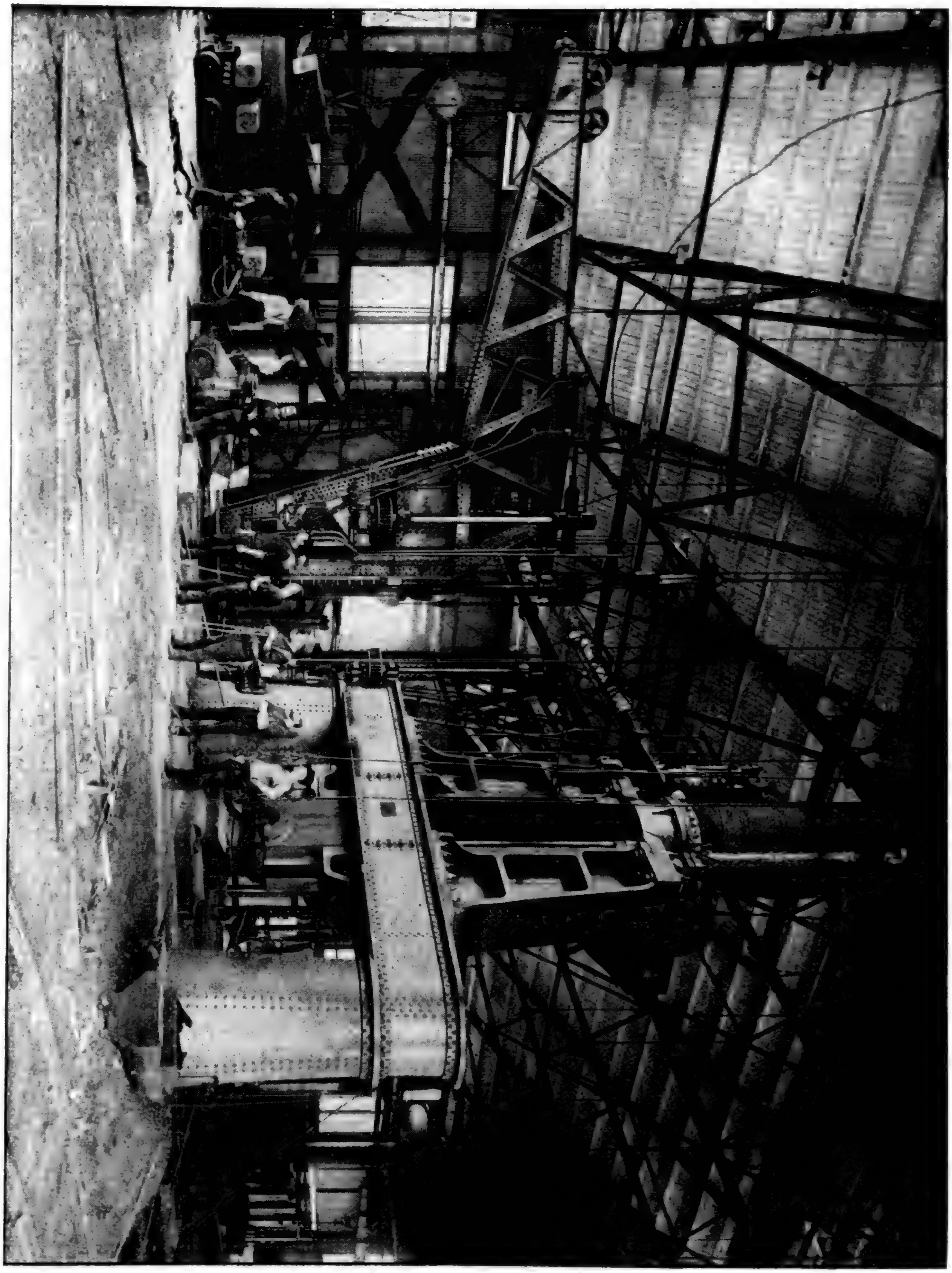


TWENTY-TON STEAM HAMMER AT THE PENCOYD IRON WORKS.

The piston is of steel, and is simple in construction and sufficiently light to admit of a certain elasticity or spring.

The packing consists of ordinary split rings, four in number, sprung into recesses in the usual way. The upper head of the cylinder is simply a light iron plate, its only purpose being to prevent dust, etc., from falling into the cylinders.

The engraving shows the arrangement of heating furnaces on one side of the hammer; on the other side—partially concealed in the cut by the hammer itself—is a similar set of furnaces, so that there is no delay in providing work for the hammer. There are two cranes—one shown in the engraving and the other, like the second furnace, partially concealed by the hammer itself—which are exactly similar in construction. These cranes have a capacity of 20 tons, an effective lift of 16 ft., and a span of 25 ft.; they can swing a little over a quarter of a circle. The general construction of the frame will readily be understood from the engraving. The lattice-girder, of which the body of the frame is composed, turns upon a heavy wrought-iron pillar or mast, which is 24 in. in diameter and projects 14 ft. 5 in. above the base-plate. These base-plates, upon which the cranes rest, are heavy plates of cast-iron 11 ft. × 11 ft. × 3 ft. thick, resting upon suitable foundations, and the mast or pillar for the cranes, which is tapered on the base, fits into a corresponding recess in the plate. The cranes are worked by three hydraulic cylinders, one being used for swinging the crane around, the second for working the traversing carriage or trolley, which runs on top of the girder, and the third for raising and lowering the chain. In ordinary use these hydraulic cylinders carry 425 lbs. working pressure, but they are built to carry a maximum of 700 lbs., so that the work of the cranes can be increased if necessary.

The whole arrangement of furnace, cranes, and hammer is a very convenient one. The track, which runs the entire length of the works, passes close to the hammer on the side opposite to the furnaces, so that the ingots or other work can be transferred directly from the hammer to a car, upon which they can be carried to the point where it is desired to have them.

This hammer is one of the largest in this country, and has done very satisfactory work since it was put in service a few months ago. That the foundation is an excellent one is shown by the fact that since it was first set up, the anvil-block has sunk only about 4½ in., with the hammer at full work, and the vibration of the ground close by is very slight.

THE DEVELOPMENT OF ARMOR.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 516.*)

II.—HOW ARMOR IS CLASSIFIED.

So long as the artillerist confined himself to shot of cast-iron, and wrought-iron held undisputed possession of the field as the metal for armor, the attack and defense in warfare were fairly well matched. That cast-iron for projectiles was decidedly inferior to steel and wrought-iron had been abundantly proven during the earlier experiments with armor, by Whitworth and others, but it was not until the invention of chilled cast-iron shot that the necessity for a new departure in the matter of armor-plate became apparent.

The introduction into the problem of this new factor, of a projectile that had sufficient hardness to pierce and tenacity to hold together when brought in contact with wrought-iron, revolutionized the whole question of armor defense. The armor that was amply able to keep out shot of cast-iron was perforated with perfect ease by the same gun and powder charge firing one of the new projectiles. In other words, the adoption of hard projectiles meant the withdrawal of soft armor.

Before entering into the discussion of the question of the practical use of armor it may be well to give some description of the different varieties, and of the methods employed in their manufacture.

All the different varieties of armor-plate may be classified under one of two heads—soft armor or hard. The behavior of the two kinds when subjected to the blow of a projectile is entirely different. Soft armor opposes the tenacity of its metal to the penetrating effort of a shot. The force of the blow is absorbed locally, and the damage inflicted is confined to the immediate vicinity of the point of impact. There is a crowding up of the particles of metal before the point of the shot, and, if complete perforation takes place, a tearing away at the back of the plate. There is little or no transfer of the shock to the surrounding metal. The attack must depend wholly upon its ability to perforate, to get through the plate in a comparatively uninjured condition, otherwise the value of the shot is lost.

Hard armor, on the other hand, depends for its success upon its ability to withstand penetration—that is, a blow to be efficient against this class of armor must be delivered with energy sufficient to shatter and break up the plate. Theoretically, at least, the possibility of penetration must never be admitted in calculating the resisting power of hard armor-plate. That plates of this description are not infrequently perforated at the experimental butts is, of course, a fact. The aim is, however, to oppose sufficient hardness at the face of the plate, that the energy of the shot may be made to act destructively against itself.

Wrought-iron, in whatever form used, comes under the head of soft armor. As at present employed, hard armor has three subdivisions—*Compound* (a union of wrought-iron and steel), *Steel*, and *Cast-iron*.

III.—SOFT ARMOR.

It took 20 years of experiment to develop from the single thin plate of wrought-iron with which armor experiments began, the solid rolled plate of the same material, of from 6 in. to 8 in. in thickness, which had been reached about the close of our Civil War. Laminated armor, made up of single plates, usually an inch in thickness, had been the natural direction of armor development. It had been thoroughly tested, both with experimental targets and in actual battle, and had been found wanting. It should be said, however, that laminated armor, when employed upon a curved surface, as on the turrets of the *Monitors*, gave much better results than when exposed on a flat surface. Fig. 1 represents the 11-in. laminated armor on the *Monitor* turrets.

The superiority of the solid plate over a laminated one of 1-in. plates, of the same thickness, is very considerable, and is given at various figures, from one-third greater strength to that which varies as the square of the thickness. The latter is probably excessive, for experiments have not shown that a solid 3-in. plate offers equal resistance with a 9-in. built-up one.

With the gradually increasing thickness of armor-plate, corresponding to the growing power of the gun, it was found that there was a practicable limit to the thickness with which solid wrought-iron plates could be produced, and at the same time secure a uniform quality of metal throughout. Beyond 12 in., or, at most, 14 in., it was found difficult to obtain homogeneity of structure. Plates of much greater thickness have been made and experimented with, but the thickness here given is that from which fairly certain results can be predicted. Added to this, was the greatly increased cost of manufacture and the difficulty of accurately joining the plates together.

To escape these difficulties, and still secure proper thickness of metal, further experiments were had, first with plate-upon-plate armor—that is, placing the solid plates in juxtaposition—and afterward with what is known as sandwich armor, or armor where the plates are separated by layers of wood.

In the Russian experiments of 1869 an 11-in. Krupp steel projectile of about 500 lbs. in weight was driven through 15 in. of wrought-iron in two plates, three 1-in. intermediate plates, and 36 in. of wood backing. Up to this time

this was by far the best showing for the gun. Three years later the failure of the 12-in. 25-ton English rifle to perforate or disable the 12-14-in. turret of the *Glatton* showed the advantages of metal when disposed in a circular structure over that exposed on a flat surface.

During 1876-77 a series of experiments were conducted in England against sandwich armor. A 12.5-in. rifle was

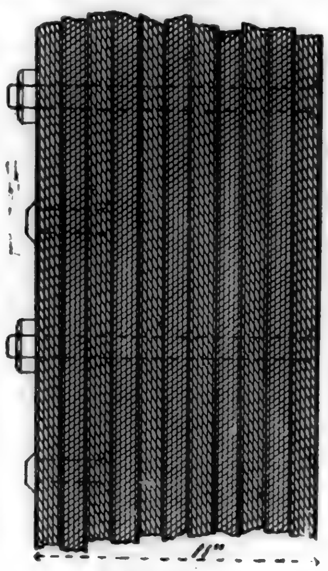


FIG. 1

able to perforate three 6.5-in. solid plates separated by 5-in. layers of teak. The same gun, when fired with an increased charge against the same target, strengthened by the addition of a fourth 6.5-in. plate and another 5-in. layer of teak, failed to get its projectile through the last plate. To test the relative powers of resistance of solid and sandwich armor, a solid 16.5-in. wrought-iron plate, considered equal in strength to the three 6.5-in. plate target above referred to, was attacked by the same gun. A sand-weighted Palliser shell was driven through it without difficulty.

During further experiments with sandwich armor, a target of four 8-in. plates of wrought-iron, with 5-in. layers of teak between the plates, was attacked with the 16-in. 80-ton gun and a 1,700-lb. projectile. The projectile failed to get through, was stopped after penetrating a little over 26 in. of the 32 in. of iron, and the intermediate 15 in. of teak. At a second trial with the same gun, chambered, and with a considerably increased charge of powder against the same target, the projectile penetrated only about 27 in. of metal, but bent back the rear plate of the target some 14 in.

With these experiments the testing of wrought-iron plates may be said to have terminated. The results of the Spezia armor-trials of the year previous, when hard armor had for the first time been put to the test, had shown conclusively that the era of the soft armor-plate had closed.

IV.—HARD ARMOR.

Although experiments with hard armor had been made 20 years before, it was not until the Italian tests in 1876, above referred to, that it had been brought in actual competition with wrought-iron. Up to this time both for use on war vessels, and generally for experimental purposes, this latter metal had held possession of the field. The advent of the 100-ton gun gave such promise of advantage to the attack that new impetus was given to efforts looking to the improvement of armor-plate. In France, and by Whitworth in England, steel had been advocated, and had, at irregular intervals, been seen upon the trial-ground both alone and in conjunction with wrought-iron, but up to that time had never received a thorough test. In 1862 the English Committee on Iron had pronounced against steel or steely iron for armor-plates, while as late as 1874 one of the best English metallurgists, commenting on an experiment that had been made by Armstrong with an oil-tempered steel plate, tells us that iron is superior to steel for purposes of armor.

The Italian Government, which was at this time building the first two of its monster armor-clads—the *Duilio* and the *Dandolo*—before deciding upon the question of their armor, inaugurated a series of experiments at Spezia to test the claims of the armor-plate-makers of Europe. These experiments attracted widespread attention and conclusively demonstrated the superiority of hard over soft armor. Without going into the details of this trial it will be sufficient to say that the targets submitted were intended to represent, as nearly as might be, the thickness of armor that had been decided upon for the new vessels, which was something over 22 in. of metal, including the inner skin, and 29 in. of wood backing. The plates submitted were one English 22-in. solid wrought-iron (Cammel & Company), one French plate of the same material and dimensions (Marrel Frères), and two solid steel 21.65-in. French plates (Schneider & Company). In addition to these both Cammel and Marrel submitted sandwich targets of the usual pattern, aggregating 22 in. of metal, and, besides, each supplied one in which the 22 in. of iron were divided between 8 in. of wrought and 14 in. of chilled cast-iron. Cammel placed these latter plates in juxtaposition, while in the Marrel plate, the cast and wrought-iron were separated by a layer of wood. The test was to be a number of rounds from guns of moderate caliber (10-in. and 11-in. rifles) and one round from the 100-ton gun. All the targets withstood the smaller projectiles fairly well, but that from the heavier gun effected with ease complete perforation in all except the solid steel Schneider plate, which, although shattered and thrown down, had successfully kept out the 2,000-lb. projectile, with a striking energy of something over 30,000 foot-tons. It is not to be wondered at that after these experiments renewed attention should have been given to hard armor.

V.—COMPOUND ARMOR.

Compound armor, as at present understood, is a combination of iron and steel—a hard steel face joined to a wrought-iron back. It is the type of armor invented in and adopted by England.

The idea of joining iron and steel together in one plate was by no means new at the time of the Spezia experiments in 1876. But in the earlier attempts to join the metals the steel plate was usually welded to its companion, sometimes to the face, sometimes to the back, and in other cases placed between two plates of iron ; or the plate was made up of alternate layers of iron and steel welded together. Cammel & Company had entered the lists as early as 1867 as manufacturers of armor-plates made up of a combination of iron and steel, but it was not until 10 years later that they produced their first compound plate manufactured upon the lines now generally adopted.

There are two firms engaged in the manufacture of compound armor-plates in England, by whose names the two varieties of armor are generally known—Cammel & Company and Brown & Company, both of Sheffield. These are also frequently referred to by the names of the patentees —Wilson and Ellis. Armor under the Wilson patent is also manufactured in France, in Germany, and in Russia. The Cammel plate is now manufactured under two patents known as No. 1 and No. 2.

Cammel & Company's Plate, No. 1 (*Wilson's patent*). In the manufacture of this plate, shown in fig. 2, the foundation-plate or backing is built up of many thin plates rolled down to the thickness of the plate required. It is then raised to a welding heat, placed in an iron mold or chamber, which revolves on trunnions. The mold is then turned to a vertical position and liquid steel (Siemens-Martin, or open-hearth) is poured from a ladle and trough between one side of the wrought-iron and the side of the mold, precaution being taken to prevent its flowing elsewhere. As soon as sufficiently cold it is taken from the mold, reheated, and rolled down to its final thickness, in one heat if possible. The steel being of higher temperature than the iron carbonizes the iron to a depth of from $\frac{1}{4}$ in. to $\frac{1}{2}$ in., forming a zone of mild or semi-steel and a strong welding joint. The steel face contains about 0.7 per cent. of carbon.

In the earlier process the wrought-iron plate was placed horizontally and the liquid steel poured over the face of the

plate. This was abandoned because the scum remained on the face of the plate and impaired its quality.

Under the Cammel, No. 2, or Wilson's improved process, to produce a 20-in. finished plate, a plate of about 15 in.

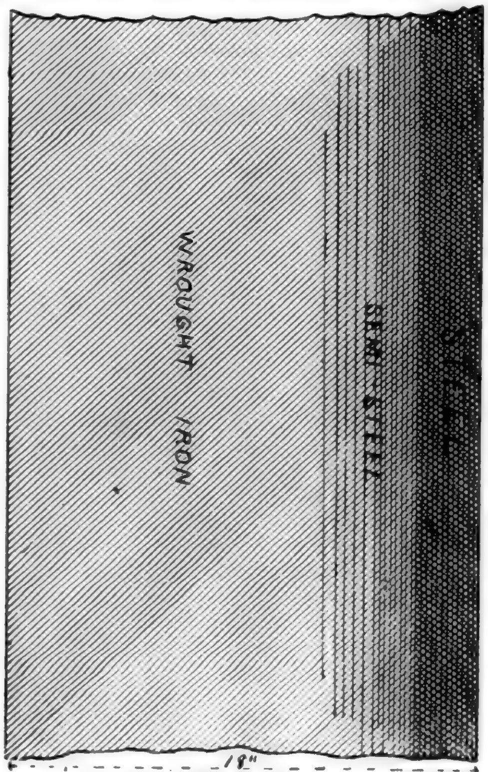


FIG. 2

in thickness is built up of a number of thinner plates as before. After this plate is forged, and before cooling, it is placed in an iron mold about 28 in. in depth, and upon its face is run a layer of very mild steel—Bessemer or

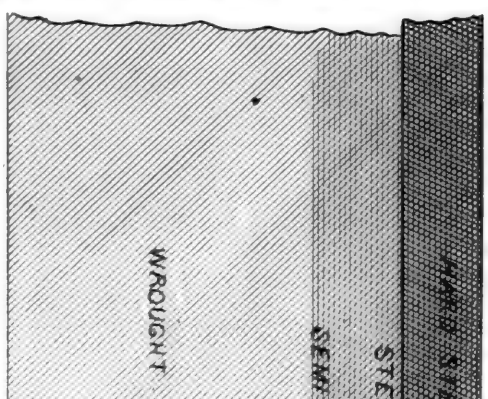


FIG. 3

Siemens-Martin—about 13 in. in depth. When cool the plate is taken from the mold, reheated, and then rolled or hammered until the thickness is reduced to about 18 in. This forms the back of the compound plate. After being replaced in the mold a layer of hard steel, about 8 in. in thickness, is run upon the originally exposed face of the wrought-iron plate, giving a thickness of about 26 in. It is then removed from the mold and after being reheated is reduced by rolling or hammering to the required thickness of 20 in. The hard steel face of these plates contains from 1.25 to 1.50 per cent. of carbon.

Sir John Brown & Company's Plate (*Ellis patent*). In manufacturing this plate, shown in fig. 3, a soft, wrought-iron backing is prepared in much the same way as in the ordinary Wilson process. A hard, steel-finished plate is also prepared. The steel plate is laid over the foundation-plate, their surfaces being kept about two inches apart by wedges and small steel studs. The whole is then heated in a furnace with the plates horizontal. When hot it is removed and lifted by a crane and swung into a vertical mold in a pit, a hydraulic ram in the mean time holding the plates firmly. Melted steel (Bessemer, usually) is then distributed from a trough, in small streams, into the space between the two plates, joining them together. After being taken from the mold the plate is reheated and passed through the finishing rolls.

In the fabrication of both the Cammel and the Brown plates the greatest difficulty lies in the formation of a perfect weld between the iron and steel, and in the latter between the steel and steel. In the Brown plate there are two surfaces to be joined instead of one, as in the Cammel armor. Under fire the metals are apt to separate, the steel face flaking off from the soft iron backing. This is said to be more liable to occur in the Brown than the Cammel plate.

The advantage claimed for the Brown plate is that a perfectly finished face of known hardness is secured, which, of course, is not the case with its rival. It has the disadvantage before stated, that the union between the face and back is less perfect.

These two rival systems of compound armor about equally divide the favor of English artillerists and metallurgists. Under actual firing tests there seems little to choose between them.

The plates, as generally made, are about 8 ft. by 12 ft., and weigh, for the thicker ones, from 45 to 50 tons each. About one-third of the thickness of a compound plate is of steel, and two-thirds of wrought-iron.

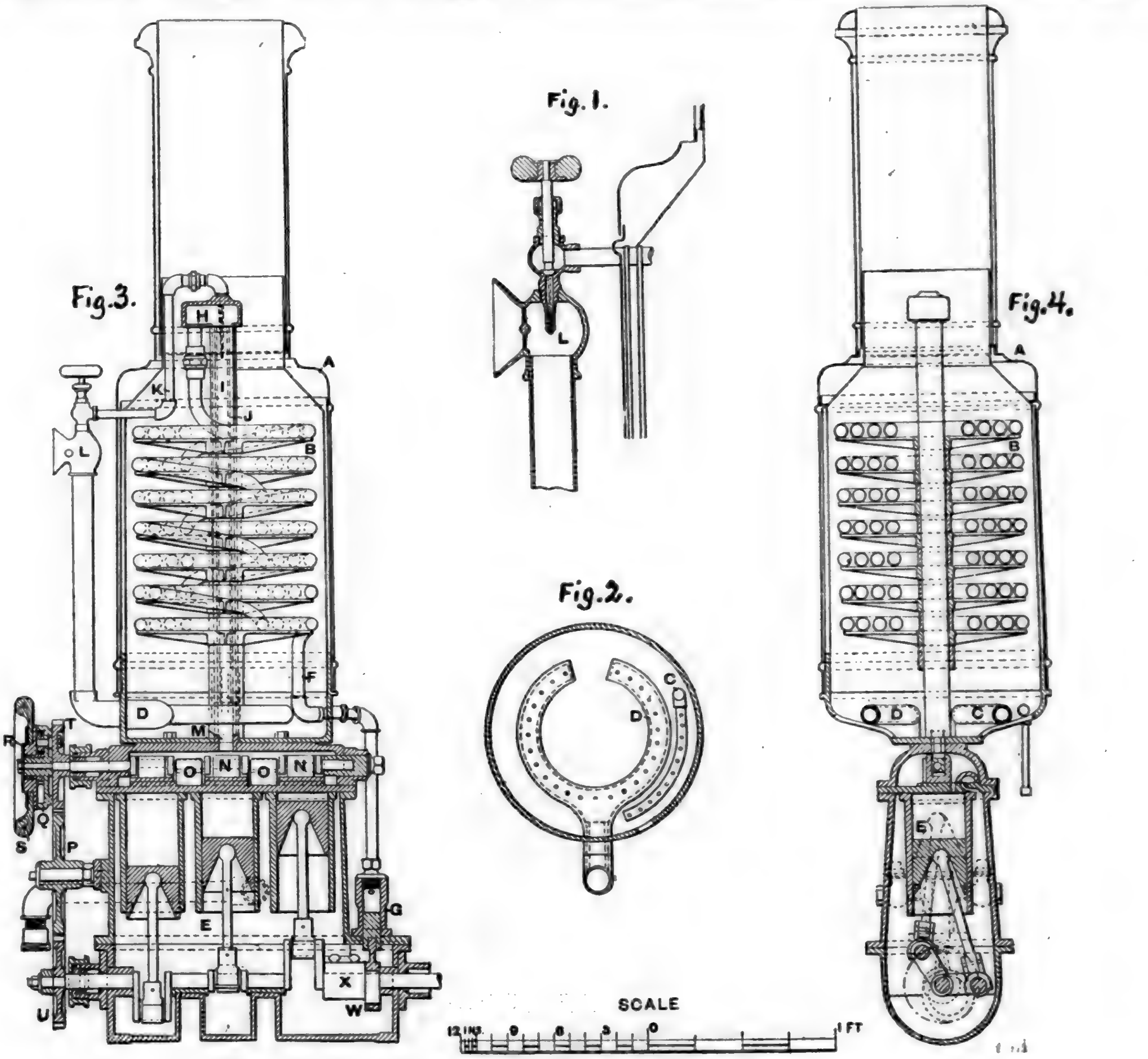
(TO BE CONTINUED.)

A French Naphtha Launch Engine.

(From *Industries*.)

Among the petroleum vapor launch engines at the Paris Exposition is one exhibited by La Société Anonyme des Anciens Etablissements Cail, who obtained, about the end of last year, the exclusive right to manufacture in France and its colonies and protected dependencies M. de Quillfeldt's petroleum vapor engine for river and sea-going craft. As there are some novel points in the Quillfeldt engine, we propose to describe it in detail. Fig. 3 is a longitudinal section through the center line of the generator and motor, and fig. 4 is a cross section through the center of the middle cylinder and generator. From these illustrations it will be seen that the motor consists of a three-cylinder engine, the cylinders being single-acting, and about 3 in. in diameter by 4-in. stroke. Immediately above the engine is the vaporizing apparatus, making a very compact arrangement. The burners *C D* (fig. 2) for raising the temperature of the petroleum are placed below the spiral tubing of copper in which the oil circulates, so that a considerable amount of heat is radiated to the cylinders, thereby maintaining the temperature of the spirit vapor and increasing the efficiency of the motor. The principal feature of the Quillfeldt motor is that instead of having two distinct qualities of oil in the storage tanks—viz., gasoline and petroleum, only the latter is required, which, it is claimed, obviates the possibility of disastrous explosions, and has also the advantage that there can be no difficulty in obtaining the oil in all localities, since ordinary petroleum is to be bought everywhere. The generator *B*—a copper coil surrounded with a cylindrical casing *A*—is supplied in the first instance with petroleum by means of a small hand-pump, the operator also alternately working a small air-pump, thereby introducing into the auxiliary burner *C*, placed at one side of the principal burner *D*, a mixture of air and vapor, which is ignited by a torch. After ignition the operator continues to work the

hand-pumps for from three to four minutes, when the petroleum in the coil *B* becoming heated, is divided into light and heavy vapors, both of which rise through the pipe *J* into the box *H*, where the lighter vapor passes out of the top of the box and through the pipe *K* to the injector *L*, of which we give an enlarged view in fig. 1. From this illustration it will be seen that a valve is fitted into the funnel-shaped opening of the injector for the automatic admission of the air required to be mixed with the light petroleum vapor to produce combustion in the burner *D*. The draught of the funnel, aided by small openings in the outer casing *A* underneath the burners, proves sufficient for the efficient consumption of the combined petroleum vapor and air, the products of combustion passing directly into the chimney. Meanwhile the heavier vapor escapes from the box *H* by the pipe *I*, descending which it enters the valve chest common to the three cylinders by the opening *M*, and then acts through the pump, *G*, serves to draw petroleum from the reservoir at the fore end of the boat, and force it into the vapor-generating coil by the pipe *F*. The rod of an eccentric, *W*, placed on the main shaft near *X*, gives the requisite motion to the plunger of the pump *G*. A pressure-gauge connected to the slide-valve casing is fitted on the port side, and a safety-valve on the starboard side; but in practice the latter should rarely be in operation, because if the pressure is increasing too rapidly, a slight adjustment of the injector will soon diminish the supply of vapor to the burner, and check the increase of pressure. An internal arrangement is also fitted in connection with the pipe *K* to prevent an excessive amount of vapor passing to the burner. This is, however, only necessary if a kind of oil is used sensibly different from that for which the engine has been designed. In practice it is found that the proportion of light vapor given off from ordinary petroleum is just sufficient for the heat supply



DE QUILLFELDT'S NAPHTHA LAUNCH ENGINE.

revolving slide valves *N* upon the pistons. The cranks are set at an angle of 120°, the shaft being carried upon bearings formed in the bed-plate. The shafting actuating the slide-valve motion is similarly supported at *O O*, and the reciprocal position of the main and slide-valve shaft is such that the slide valves are full open at the commencement of the downward stroke of each piston, so giving a most effective distribution of vapor. The slide-valve shaft is driven by gearing off the main shaft, the spur-wheel *U* actuating the intermediate toothed-wheel *P*, which transmits the motion to the geared-wheel *T* on the valve-spindle. This gearing arrangement does not merely transmit motion to the slide-valves; it is also utilized for reversing, starting, and stopping the mechanism. To reverse the motion from go ahead to go astern, the wheel *S* is turned in a direction contrary to its motion. After the engine is once in motion there is no longer any necessity to pump either air or petroleum by hand. As already explained, the air supply is automatic, while a feed-

to the generator and no more; but should there occur a variation in the specific gravity of the petroleum, it might upset the delicate adjustment of the heavy and light vapors, and hence means for checking readily the passage of light vapor to the burner have been provided.

After the petroleum vapor has been utilized as the working agent, it exhausts from the cylinders into a condenser formed of tubes laid alongside the keel of the boat, from which it returns into the storage tank. When the engine is once set in motion, its operations are entirely automatic, and hence it does not require a skilled attendant.

The consumption of oil is stated at about 1 gal. per hour for a 2-H.-P. motor, which, at a specific gravity of 0.80, is equal to 4 lbs. of fuel per indicated H.-P. per hour. Similarly, the mean result for the 4-H.-P. engine is a consumption of 2.90 lbs. petroleum per indicated H.-P. per hour. These figures, however, must be taken only as an approximation.

Apart from the question of economy, however, there is no question that these vapor launches, with a compactly arranged motor like this one, have advantages over the ordinary steam launch, in giving more room for passengers and in the absence of noise, smoke, waste, and exhaust steam. With ordinary care there seems to be no risk of explosion.

Griffin's Car-Wheel Grinding Machine.

THE accompanying illustrations show a machine for grinding and truing up the treads and flanges of car-wheels. As will be seen, it is so arranged as to carry two wheels at once, each wheel being acted upon by two emery-wheels or grinders. This machine has a further advantage, that it is not necessary to mount the wheels upon the axles, as they are carried by expansion mandrels which hold them upon the spindles. The main spindles are independent of each other, so that when the wheels are on the machine, the action of either one is entirely independent of the other, or one wheel can be finished at a time if desired.

In the accompanying drawings fig. 1 is a plan of the machine; fig. 2 a front elevation; fig. 3 a section on the line *x x* of fig. 1, and fig. 4 a longitudinal section on the line *y y* of fig. 1. The inventor's description is as follows:

"*A* is the bed-plate or foundation-plate of my machine, it being fastened upon suitable foundation-timbers, etc., *B B*, by means of foundation-bolts *C*, as illustrated in figs. 1, 2, and 3. This bed-plate is of the shape of the letter **H**, the four members *D* of which serve to receive each a slide-rest *E*, fig. 1, carrying an emery-wheel in the manner hereinafter to be referred to. Each of the members *D* of the bed-plate has two **T**-shaped slots 1 1, wherewith engage the heads of the bolts 2 2, fig. 2, by means of which the said slide-rests are movably secured upon said members *D*, a further serrated groove 3 being placed about midway between the T-slots to enable the slide-rest to be moved with a crow-bar (not shown) inserted into one or the other of said notches and the slide-rest moved back and forth in an obvious manner.

"Upon the central longitudinal portion of the bed-plate *A*, are placed three standards *F F' F"*, the first of which is located in the center of the bed-plate and receives all the terminal ends of the shafts and spindles hereinafter to be named. Each of these standards has two bearings, 4 and 6 being respectively the lower and upper bearings of the central standard, and 5, 7, 5', and 7', respectively those of the outside standards. The upper bearings carry spindles *G G'*, upon which are loosely-revolving pulleys *H H'*, formed together with pinions *I I'* in one piece, said pinions engaging spur-wheels *J J'*, fastened upon sleeves *j*, revolving upon fixed shafts *K K'*, held in position by means of set-screws *k k'*, in the central standard *F*, as clearly illustrated in fig. 4. The sleeves *j* are formed in one piece with pinions *L L'*, which in turn engage spur-wheels *M M'*, fastened to the spindles *G G'*, by keys *m*, and by means of which the said spindles are revolved from the pulleys *H H'*, the proportions of the gearing employed being such as to revolve the car-wheels *N N'* at a slow speed.

"The ends of the spindles *G G'*, projecting from the standards *F' F"*, are internally screw-threaded, so as to receive expansion-mandrels, the construction of which will hereinafter appear.

"In front of the standards *F' F"* are laid tracks *P P'*, upon which trucks or cars *Q* are placed, to handle the car-wheels, as hereinafter to be particularly referred to.

"The slide-rests *E*, heretofore mentioned, are all alike, with the exception that two of them are right and the other two are left, so that a description of one will aptly apply to all. In fig. 3, the base 10 has flanges 11, by means of which and bolts 2 it is removably secured upon the member *D* of the bed-plate. Upon this base is secured the stand 12 by means of screws 13, which stand has ways 14 for a traverse 15 on its upper side, having the slide 16 moving at right angles to the traverse 15, and provided on its upper surface with two bearings 17, carrying between them a pulley 18, which pulley is secured to a mandrel 19, the forward end of which has an emery-wheel 20, all as clearly illustrated in figs. 1 and 3. The traverse 15 is moved by a screw 21, having on its end a hand-wheel 22 and a ratchet-wheel 23, there being further secured upon said screw a lever 24, figs. 1 and 3, which actuates said ratchet-wheel (and with it the screw 21) by the pawl 25 and spring 26. This spring 26 is of substantially U-shape, one member being fastened to said lever 24, and its free end pressing upon the tail of the dog or pawl 25 in a manner easily comprehended.

"To the bed-plate *A* are fastened four supports 27 (fig. 1 showing but one, and figs. 2 and 3 but two thereof, they having been omitted from said fig. 1 so as not to crowd the same with details which would have a tendency to obscure the drawings), to the upper end of which are pivoted levers 28, having their fulcrum about midway of their length. One of the ends of these levers reaches a short distance beyond the periphery of the spur-wheels *M* or *M'*, so as to come in contact with pins 29, which pins depress the ends of these levers on one side of the machine and lift the opposite set of levers on the opposite side, the motion up or down depending upon the direction of revolution of the machine. To the end of the lever 28 is pivoted a rod 30, which connects said lever with the lever 24 by means of a bolt 31, there being a series of bolt-holes 32 in these various levers, so as to lengthen or shorten their throw at pleasure, and thereby the feed of the slide 16, together with the emery-wheel 20, in a manner readily comprehended.

"The stands 12 are movably fixed to the bases 10, so as to enable them to revolve around a fixed center, and thereby to be set at an angle to the center line of the axes of the main spindles *G G'*, the angle being that of the tread of the car-wheels *N*, so that the latter will be trued up by revolving both the car-wheels and the emery-wheels in a proper direction from suitably-arranged countershafts (not shown) placed overhead, and having belts 34 to operate the emery-wheels 20 and other belts 33 to drive the pulleys *H H'*, as illustrated in the drawings.

"To remove the dust and grit caused by the operation of the emery-wheels upon the car-wheels, hoppers are placed 35 under each wheel, and connect these hoppers by means of ducts 36, with an exhaust-fan 37, receiving motion through the belt 38 in an obvious manner.

"The trucks used for bringing the car-wheels to the machine and removing them when finished, have in their platform curved, step-like depressions 9, so arranged as to fit the various diameters of car-wheels in one or the other of these depressions. A car-wheel is placed upon this truck in an erect position, resting with its tread in its respective curved depression, so that when it reaches the machine it stands just right in height to slide upon the expansible mandrel, where a few turns of its spindle-screw with a suitable wrench will immediately secure the wheel in proper position, while to remove the car-wheel from the machine the truck *Q* is run under it, the mandrel contracted, and the truck with its load moved away. These trucks have axles 41, running in bearings 42, secured underneath the platform, said axles having flanged truck-wheels 43 running upon the tracks *P* on both sides of the machine.

"The expansible mandrels heretofore mentioned consist each of a tapering nose or projection 44, formed either in one piece with the main spindles *G G'*, or they are separate pieces screwed into the said spindles. In this tapering portion 44 there are three grooves 45, dovetailed to receive a wedge-shaped jaw 46, having a dovetailed portion 47 fitting the dovetailed portion of said grooves—a nice fit. Each of these jaws has near its forward end a lug 49, having parallel sides to fit between a collar 50 on the screw-spindle 51, and a further collar 52, secured to said spindle, the jaws being moved longitudinally in said grooves by turning the screw-spindle 53 with a wrench placed upon the wrench-section 51 on the end of said screw-spindle. The lugs 49 are parallel because they move radially between the collars 50 and 52 when the screw-spindle is revolved, and so retain a fixed position relative to the said collars and the spindle. It will now be readily observed that motion being given to the car-wheels by starting the machine and then feeding the slides 16 by means of the feed-screws 39 and hand-wheels 40 to the tread of the car-wheels, and then starting the emery-wheels and the self-feeding mechanism of the traverse 15, by throwing the pawls 25 into action the traverse will feed the emery-wheels over the surfaces to be reduced, it being a matter of fact that this machine will finish 40 car-wheels in a thoroughly satisfactory manner in 10 hours with but one attendant to the machine and one laborer to supply the wheels and remove those that are completed."

This machine is covered by patent No. 411,344, issued to P. H. Griffin, of Buffalo, N. Y., under date of September 17 last.

Manufactures.

Locomotives.

THE Schenectady Locomotive Works, Schenectady, N. Y., are building 25 new engines for the Lake Shore & Michigan Southern Railway; three of these are heavy passenger engines, 15 mogul freight, and seven switch engines.

RECENT orders at the Baldwin Locomotive Works include 14 freight engines for the Lehigh Valley Railroad, and 11 mogul freight engines for the Fort Worth & Denver City Railroad. The works recently completed several passenger engines for the Baltimore & Ohio Railroad, which are built to burn coke and which will be used on the line between Philadelphia and Washington.

THE Schenectady Locomotive Works are preparing to begin the construction of a mogul compound locomotive. The engine will be of about the same power as ordinary moguls of the same weight, and will have two cylinders arranged in the same way, except that one will be large enough to perform the duties of a low-pressure cylinder. Mr. A. J. Pitkin, Superintendent of the Schenectady Locomotive Works, has designed this engine, and some inventions that he has got out for regulating the admission of steam to the cylinders have been covered by letters patent. Steam will be admitted to the low-pressure cylinder direct in starting, but reduced in pressure so that the power transmitted on that side will never be greater than that transmitted by the small high-pressure cylinder. The mechanism of the compound locomotive will not be any more complex than that of a simple engine, and it will be as easily operated. The intention is to subject this engine to searching tests working

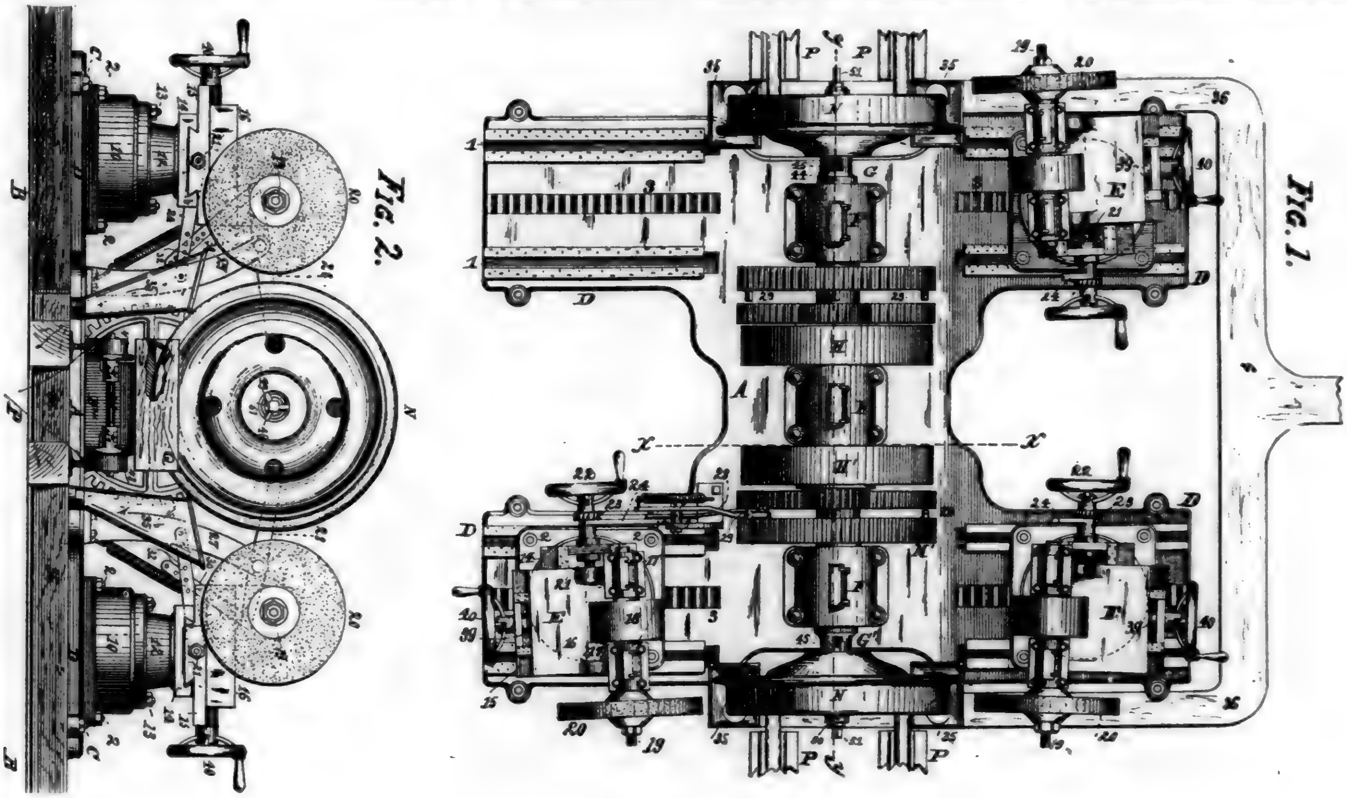


FIG. 2. FIG. 1.

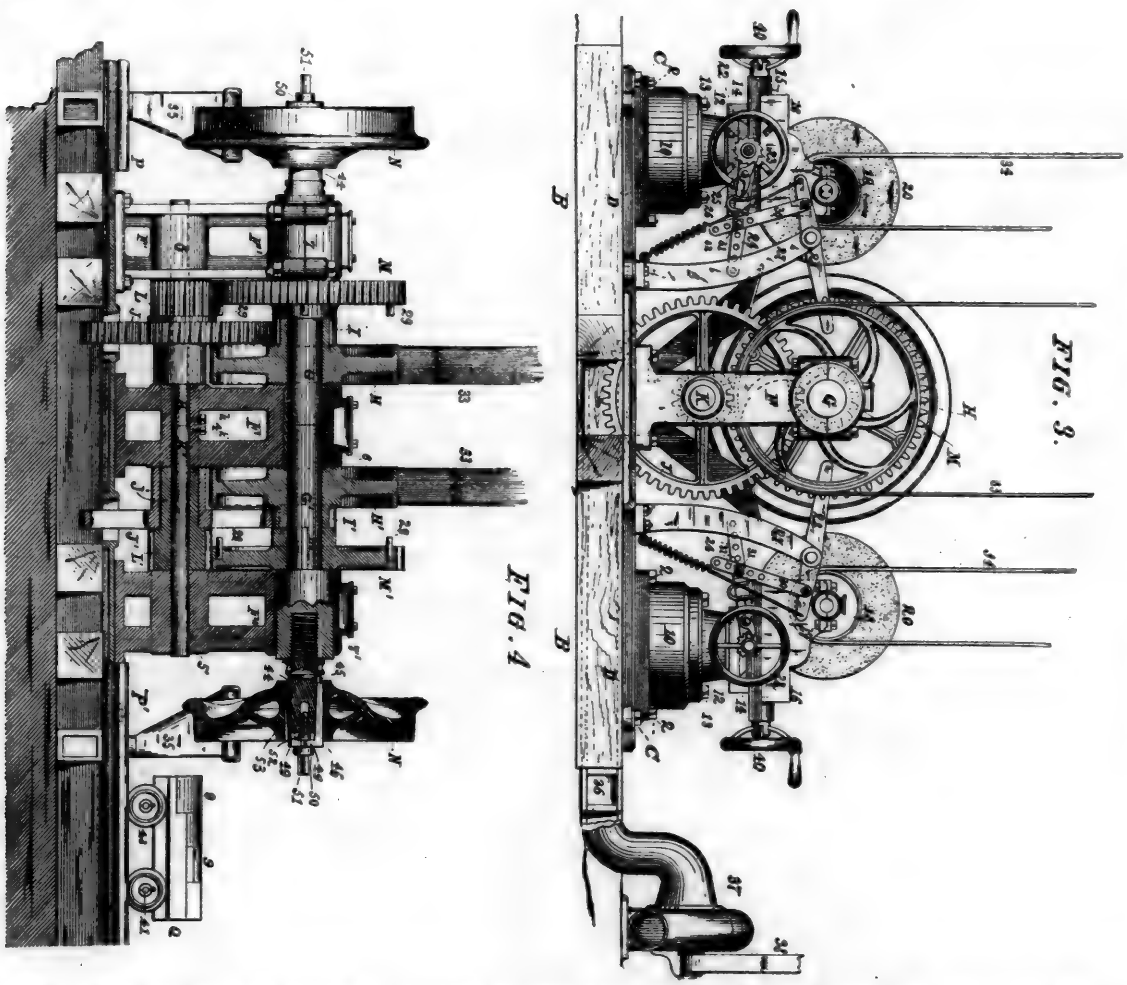


FIG. 4. FIG. 3.

MACHINE FOR GRINDING CAR-WHEELS.

against a common engine of the same capacity. The builders are determined to know exactly what there is in the compound locomotive.—*National Car-Builder.*

THE Baldwin Locomotive Works, Philadelphia, are building three ten-wheel passenger engines for the New York, Lake Erie & Western Railroad. These engines, which are intended to run the heavy express trains on the Eastern Division, will have 20 × 24-in. cylinders, six 68-in. driving-wheels, and a four-wheeled truck.

THE Rogers Locomotive Works, Paterson, N. J., are building a snow-plow for the Jull Manufacturing Company, which is to be used on the Pennsylvania Railroad.

Bridges.

THE Pencoyd Bridge & Construction Company, Philadelphia, has a contract for a bridge across the Schuylkill River for the Philadelphia & Reading Railroad.

THE St. Louis Bridge & Iron Company has recently taken contracts for iron bridges in Adams County, Ill. ; at Topeka, Kan. ; at Iola, Kan., and at Poplar Bluff, Mo., over Black River.

THE Kansas City Bridge Company, Kansas City, Mo., has a contract to build an iron bridge over Chacon Creek at Laredo, Tex.

THE bridge over the Hudson River, between Jersey City and New York, which was proposed by Mr. Gustave Lindenthal, is to be represented by a model which is now being constructed at Hazelwood, near Pittsburgh. As our readers will perhaps remember, the plan is for a bridge with a central span 2,850 ft. in length, with two shore spans each about 2,500 ft. The structure is to be a suspension bridge, with roadway 140 ft. above high-water mark, the towers being about 500 ft. in height. It is intended to carry six railroad tracks. It is understood that Mr. Lindenthal means to ask Congress for assistance in building the bridge.

THE Carbon Iron Company, Pittsburgh, is making the steel-plates and bars for the Red Rock Bridge—the 660 ft. cantilever bridge which is to cross the Colorado River on the Atlantic & Pacific Railroad.

THE Norfolk & Western Railroad Company is asking for bids for four bridges of 150 ft. span.

THE contracts for bridges for the Schuylkill & Lehigh Railroad have been let as follows : Little Schuylkill Bridge to the Edge Moor Bridge Works ; Schuylkill River Bridge and trestle approach to the Athens shops of the Union Bridge Company ; 1,500 ft. of iron viaduct near Schuylkill Haven to the Elmira Bridge Company.

THE bridge over the Potomac River for the West Virginia Central & Pittsburgh Railroad has just been completed by the Pencoyd Bridge & Construction Company, of Philadelphia. It has one span of 125 ft. and three of 120 ft. each.

THE Phœnix Iron Company, Phœnixville, Pa., has completed its contract for 800 tons of wrought-iron columns and 1,000 tons of steel beams for the new *World* building, New York.

THE East Tennessee, Virginia & Georgia Railroad Company is asking for bids for several 150-ft. spans of iron bridge.

THE Lassig Bridge Company, Chicago, is building a number of iron bridges for the Oregon Railway & Navigation Company, under the supervision of George S. Morison, Engineer.

THE Wilmington draw-span is nearly completed at the shops of Dana & Westbrook. Albert Lucius is Engineer in charge of the work.

THE Riverside Bridge & Iron Works, Paterson, N. J., are building an iron highway bridge over the Passaic River at Newark, N. J. It has a draw-span 196 ft. long, and two fixed spans each 66 ft. long.

THE New York, Lake Erie & Western has begun the building of a new drawbridge over the Hackensack River on the Newark Branch. The draw span will be a double-track iron-plate girder deck bridge 142 ft. long, and will be swung by a steam engine. The length of the approaches, consisting of pile trestles, will be 260 ft., each arranged in such a way that hereafter deck-plate girders can be substituted for them, thereby making the whole structure permanent. The contractor for the foundation and woodwork is Mr. D. S. Cofrode. The ironwork is being done by the Riverside Bridge & Iron Works of Paterson, N. J.

Blast Furnaces of the United States.

THE *American Manufacturer* says of the condition of the furnaces on October 1 : " In a condensed form the showing is as follows :

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	66	12,672	97	12,071
Anthracite	98	36,496	91	23,818
Bituminous	149	104,378	98	44,086
Total	313	153,546	286	79,975

" The remarkable feature of this report is the large capacity of bituminous furnaces in blast, the total weekly capacity being 104,378 tons on October 1, as compared with 92,915 tons on September 1, an increase of 11,463 tons per week during the month, equivalent to 12½ per cent. There is no doubt that this large increase in capacity is due to the greater demand for Bessemer pig iron.

" As compared with last year, the statement is as follows :

	Oct. 1, 1889.		Oct. 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	66	12,672	73	12,983
Anthracite	98	36,496	99	29,586
Bituminous	149	104,378	138	87,141
Total	313	153,546	310	129,710

" This shows material changes during the year."

FROM statistics collected by the American Iron & Steel Association, it appears that the number of blast furnaces existing in the United States, November, 1, 1889, as compared with the number on November 1, 1887, was as follows, with their yearly capacity, and also with the number of new furnaces now in construction :

Furnaces.	Nov. 1, 1889.	Nov. 1, 1887.
Anthracite	190	200
Bituminous and Coke	239	214
Charcoal	146	168
Total completed	575	582
Furnaces building	29	30
Yearly capacity of completed furnaces, in net tons	13,168,233	10.990,993
Yearly capacity of furnaces building, in net tons	1,204 000	1,122,000
Average yearly capacity of completed furnaces	22,901	18,885

This table has been carefully made up by striking from the line all the furnaces which have been abandoned, and entering all those which have been built during the past two years. It will be noted that while the actual number of furnaces shows a decrease, the total capacity is largely increased, so that the average yearly capacity is considerably greater than it was two years ago. This results from the fact that the abandoned furnaces were generally old ones of very small capacity, while the new ones are without exception large. It will also be noted that there has been a considerable decrease in the number of charcoal furnaces, and a small one in that of the anthracite furnaces, while the bituminous and coke furnaces have increased considerably. Of the 29 new furnaces now under construction, 18 are in the Southern States ; 8 of them in Alabama alone.

Cars.

THE St. Charles Car Company, St. Charles, Mo., recently delivered 17 passenger cars to the Union Pacific, and is now building 12 passenger, 4 baggage, and 4 mail cars for the same road.

THE Roanoke Machine Works, Roanoke, Va., are building 300 box cars for the New York, Lake Erie & Western Railroad.

THE Ohio Falls Car Company, Jeffersonville, Ind., is building freight cars for the New Orleans, Fort Jackson & Grand Isle and for the East Tennessee, Virginia & Georgia Railroad.

THE Terre Haute Car Works, Terre Haute, Ind., are building 100 stock cars for the Cleveland, Columbus, Cincinnati & St. Louis Railroad. These cars are fitted with air-brakes and with Janney coupler.

THE United States Rolling Stock Company is building in its shops at Hegewisch, Ill., 100 gondola cars for the Pittsburgh, Cincinnati & St. Louis Railroad.

IT is stated that negotiations have been completed for the sale of the Harrisburg (Pa.) Car Works to an English syndicate at a price satisfactory to the stockholders.

THE Missouri Car & Foundry Company, St. Louis, is building 200 box and 200 stock cars for the Pittsburgh, Cincinnati & St. Louis Railroad.

RECENT contracts reported as let for cars, are as follows: For the Chicago & Northwestern Railroad, 1,000 box cars to the Peninsular Car Company, Detroit, Mich.; 500 coal cars to the Terre Haute Car Works. For the Lake Shore & Michigan Southern, 700 box-cars to the Peninsular Car Company, Detroit, Mich.; 400 box-cars to the Barney & Smith Manufacturing Company, Dayton, O.; 200 box-cars to the Indianapolis Car Company and 100 to the Buffalo Car Works. For the Pittsburgh & Western Railroad, 900 coal cars to the Indianapolis Car Works, and 600 coal cars to Pennock Brothers, Minerva, O.

Signals.

THE Union Switch & Signal Company has taken a contract to equip the Central Railroad of New Jersey from Jersey City to Bergen Point with its pneumatic block system. The work is now in progress.

THE Johnson Railroad Signal Company has the contract for an interlocking system at Millstone Junction, N. J., on the Pennsylvania Railroad.

THE Gould-Tisdale Revolving Semaphore Company has recently sold two of its signals to the Delaware, Lackawanna & Western, and four to the Elmira, Cortland & Northern Railroad.

THE Johnston Electric Train Signal Company, Boston, has equipped several trains on the Boston, Revere Beach & Lynn Railroad with its electric train signals. This is the first practical test of this system, and it is so far giving very good satisfaction.

A SPECIAL test was made recently of the Rowell safety stop for trains, on the Old Colony Railroad near Boston. The experiments resulted very successfully. This device, which was invented by Mr. B. C. Rowell, of Boston, consists of two parts; a bar carrying a roller which is attached to the engine just ahead of the forward truck-wheel and connects with the air-brakes; the other part consists of a flat iron bar beside the rail, so arranged that when thrown into position it will strike the roller on the engine, and the air-brakes on the train will be instantly set. It is especially designed for crossings and switches, but can be applied at any desired point. Where the locomotives are supplied with this device, a portable wooden bar with iron clamps to attach it to the rail can be carried on trains and put in position at any desired point by the trainmen, when it is necessary to signal or to stop a following train.

Marine Engineering.

THE new steamer *Argus* was launched recently by the Jonson Foundry & Machine Company, New York. The boat is built for the United States Government and is intended for the use of the Supervisor of the Port of New York. The *Argus* is of steel, 85 ft. long, 15 ft. 9 in. beam, and 9 ft. in depth. The engine is a Jonson compound engine, with cylinders 12 in. and 21 in. diameter and 15 in. stroke, and steam is furnished by a Cowles water-tube boiler. This, we believe, is the first steel vessel ever built in New York.

THE Cleveland Ship Building Company recently completed the new steamer *Pontiac*, which is intended to carry ore from the Lake Superior region and is owned by the Cleveland Iron Mining Company. She has a capacity of 3,200 tons of iron ore, and is 300 ft. long on the keel, 320 ft. over all, 40 ft. beam, and 25 ft. molded depth. She has a water-bottom 3½ ft. deep divided into seven compartments, and can carry some 800 tons of water ballast. The engine is of the triple-expansion type, with cylinders 24 in., 38 in., and 61 in. diameter and 42 in. stroke. Steam is supplied by three steel boilers of the Scotch type, 11 ft. 6 in. diameter by 14 ft. long, and built to run at 160 lbs. working pressure. The propeller is 13 ft. 6 in. diameter and 17 ft. pitch. The boat is equipped with steam steering engines, steam windlass, and steam capstans, and is lighted throughout by electricity.

THE Detroit Dry Dock Company has taken a contract to build a steel steamer for the Inter-Ocean Transportation Company. The new craft will have an average length of 330 ft., with 42-ft. beam and 24-ft. depth of hold. An important feature in her construction will be the introduction of a water-bottom capable of carrying 1,000 tons of water ballast, which will enable her to face the most boisterous weather, while otherwise in light trim. The space forward of the engine, which is to be located nearly amidship, will hold about 800 tons of water, while two additional compartments, one on each side of the shaft, leading aft, are calculated to carry 200 tons more. The water-bottom space will have a depth of 42 ins. The specifications call for a capacity of 3,100 gross tons of iron ore on a draft of 16 ft. To handle such immense cargoes eight working hatches will be provided, two of them to be located abaft the engine. The propelling power is to be a three-cylinder ocean-type compound engine. The cylinders are to have a diameter of 22, 36, and 56 ins., respectively, with 42-in. stroke. Two Scotch-type boilers will furnish the necessary steam. The present intention is to make them 14 ft. in diameter and 12 ft. long, but a change from these figures may be determined upon. Because of the central location of the engine and boilers the new steamer will carry two spars only, and a single funnel encased like those on the *Owego* and *Chemung*. In her arrangement forward and aft she will present an appearance similar to the other steamers of the line. Additional deck houses will consist of separate quarters for the chief engineer, a house over the engine for engineers and firemen, and quarters forward of the boiler house for deck hands. Her outfit will embrace all of the latest improvements. Steam will be utilized in every possible direction, and a system of electric lighting introduced throughout every portion of the vessel.

THE Pacific Rolling Mills, San Francisco, recently cast successfully the steel stern-post for the new cruiser *San Francisco*. It weighs about 16,000 lbs.

THE Red Star Line is building a new steamer to run between Antwerp and New York. This steamer, which was recently launched from the Thomson yard on the Clyde, is named the *Friesland*, and is 450 ft. long, 51 ft. wide, and 38 ft. deep. She will have triple-expansion engines of the latest pattern.

THE Jonson Foundry & Machine Company, New York, is building three small steel vessels. One is a tender for the Government light-house service and is 85 ft. long. The second is a boat for the New York Fire Department, 126 ft. in length, and the third a yacht, 60 ft. long. This Company is building a number of engines of the pattern recently described in the JOURNAL. One of them is to be placed in the light-house tender mentioned above, and another has been recently sent to the Mexican Central Railroad.

A NEW steamer for Chesapeake Bay service was recently launched from the Neafie & Levy yard in Philadelphia. She is 240 ft. long over all, 38 ft. beam, and 24 ft. deep. The engine is a direct acting triple-expansion engine, with cylinders 21 in., 31 in., and 55 in. diameter and 36 in. stroke. Steam will be supplied by two boilers 13 ft. diameter and 14 ft. long, each having three 42-in. corrugated furnaces made by the Continental Iron Works. These boilers will carry a working pressure of 150 lbs. in service.

Electrical Notes.

A NEW steam launch has recently been completed at Newburg, N. Y., which is 36 ft. long and is run by a motor made by the Electro-Dynamic Company, of Philadelphia. The electricity is furnished by storage batteries made by the Electrical Accumulator Company, New York.

THE Thomson Electric Welding Company has decided to increase its capital stock for the purpose of pushing and extending its business. There are now some 75 of the electric welding machines in use, and their work has been so far very successful.

THE Weems Electric Railroad System is just now attracting much attention, and has worked very successfully on the two-mile experimental road which has been built near Baltimore. The Company expects to put up a line five miles in length near New York, also for experimental purposes. On the Baltimore line a speed of about 180 miles an hour is said to be reached.

IN May last the East Cleveland Railroad, Cleveland, O., had in operation about 17 cars, with Sprague Electric Motors. During that month these cars made an average of 94 miles a day for the whole number, one car making an average as high as 143 miles a day for the month. The cars were kept constantly at work, there being no reserve, and the work was of the hardest kind.

THE first trip over the Beverly & Danvers Street Railroad was made September 28, and the road is now in regular operation. It extends from Beverly to Danversport, being 3½ miles in length, and is operated by electricity. The road has a number of sharp curves and grades of 7 per cent., and is very successfully run, a speed as high as 15 miles having been attained on the trial trip. It is run on the storage battery system, the plant being supplied by the Union Electric Car Company of Boston, and the system being the invention of Mr. Stevens. A novel point in the system is that in running down grades where the motor is not required, the force of gravity is utilized to replenish the storage batteries. The cars in use on the road are made by the Ellis Car Company at Amesbury, Mass., and are lighted by electricity. The trial trip was made in 22 minutes over the whole length of the road, and this speed can easily be maintained in practice if required.

AN electric locomotive of somewhat novel design has just been built at the New York Locomotive Works, Rome, N. Y., for W. H. Darling. The storage system is used, the batteries occupying what would be the fire-box in an ordinary engine. The reciprocating movement of the pistons is caused by currents in helical coils wound about the cylinder, the construction being founded upon the principle that an iron plunger will be drawn into a coil of wire through which an electric current is passing.

OWING to the wonderful growth during the last decade of the electrical industry, the Superintendent of the Census has decided to have a special investigation of the subject for the report of the census of 1890. It will be intrusted to Mr. A. R. Foote, of Cincinnati, O., who has been recommended for the position by nearly all the leading firms engaged in the industry and other prominent people generally.

THE new electric light plant at Holden, Mo., is to be run by a 50 H.P. Armington & Sims engine, furnished by the Pond Engineering Company, of St. Louis. The Pond Company have also shipped to Normal, Ill., two of their largest sized feed-pumps and receivers.

Vibration in Buildings.

SOME investigations have lately been made into the question of the vibration in buildings caused by machinery in motion. These were made in connection with the Westinghouse engine, in cases where it was necessary to place engines of this type on upper floors. The theory based upon these investigations is that if the slight motion which every engine has is exactly in time with the natural vibration of the floor beam, each pulsation of the engine will increase the scope of the vibration of the floor, resulting in a most disastrous shaking, while if the pulsations of the engine are in discord with the floor, comparative quiet will exist. As floor beams are usually long, and their time of vibration correspondingly long, it is usually found that a fast-running engine will give less of its vibration to the floor beams than a slow-running one. It is also worthy of note that the vibrations of a fast-running engine are more numerous and less forcible, hence easier resisted by the mass of the floor.

An interesting example of preventing vibration by discord was shown in the case of a Westinghouse 10 H. P. engine which, on an upper story of a silverware manufactory created such a commotion as to rattle the silverware on the shelves 100 ft. distant. A change of 25 revolutions, increasing the speed, entirely stopped the vibrations.

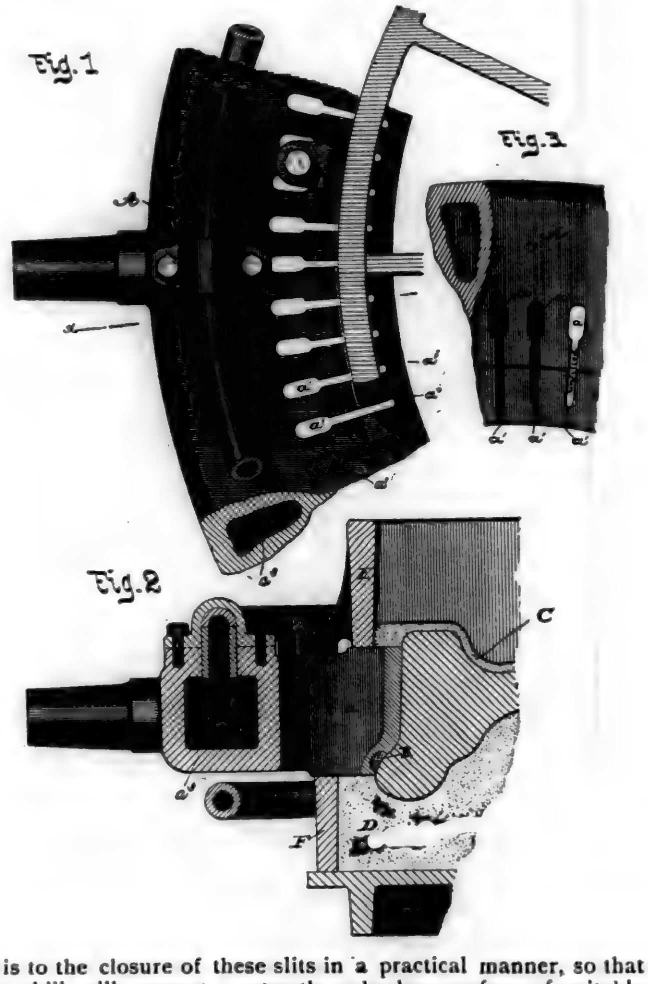
In another case—the factory of Arbuckle Brothers, in Brooklyn—two Westinghouse engines of 125 H. P. each and one of 45 H. P. are located on the fifth floor. These engines were erected on the heavy floor timbers, the floor-boards being cut away and extra timbers being inserted between the joists. Across said timbers were placed oak stringers, which have been seasoning since the war in some unfinished vessels in the Brooklyn Navy Yard. On these the engines were mounted with plain fly-wheels, and experiments were conducted to determine the speed at which it would be best to run. It was found that at 204 revolutions the vibration was at the minimum and was very slight, being as little as that caused by any of the ordinary driven machinery. The speed was therefore fixed at this point, and the wheels then made to give the proper belt speed.

Barr's Contracting Chill.

THE accompanying illustration represents a chill for casting car wheels which belongs to the class known as Contracting Chills, the surfaces of which are formed of a large number of sections separated by narrow radial slits. In order to permit the contraction of the chill, it is usually necessary to make these slits between the sections so wide that the melted metal will run into them, unless they are closed. The object of the present invention is to provide for closing the slits in such a way that the metal will be excluded without preventing the chill from contracting. It therefore consists in combining with the chill a filling of such character as will suit the requirements of the case.

In the accompanying drawings fig. 1 is a top plan view of a portion of a flask and contracting chill for car-wheels with this improvement applied hereto. Fig. 2 is a cross-section of the same on the line $x\,x$, with the wheel therein. Fig. 3 is a plan view, on a larger scale, of a portion of the chill, with the compressible filling therein.

Referring to the drawings, A represents the annular metal chill, having in its outer portion the chamber or passage a^3, to receive a cooling or heating fluid, and having on the inner side the inwardly-projecting segments or chill-blocks a, separated by slits or openings a'. The ends of the segments or chill-blocks stand side by side in a circular row, and are curved on their inner faces to correspond with the circumference of the required wheel, so that they present jointly a circular metal surface adapted to act like an ordinary chill on the tread of the wheel. The metal chill-surface is, however, interrupted or broken by the slits a, as in other contracting chills now in use.



It is to the closure of these slits in a practical manner, so that the chill will present a smooth, unbroken surface of suitable character, and at the same time be free to contract, that the invention is directed. To this end the slits or spaces a are filled with the compound of wheat or rye flour and sand, or the equivalent compounds, taking care to rub the same firmly in place flush with the inner face of the chill. After the filling is in place it is hardened, as before referred to.

It is found that the composition of sand and flour possesses practically the same degree of conductivity as the metal of the chill-blocks, and that therefore the chilling action is practically uniform and the metal of uniform hardness throughout the circumference of the tread. It is also found that the compound permits the chill to contract, that it is not burned out under the influence of molten metal or compressed under the pressure of the metal, so as to leave ridges on the wheel, and that it does not squeeze out under the face of the chill, so as to produce depressions in the wheel.

The invention is covered by patent No. 411,369, issued to Mr. J. N. Barr, of Milwaukee, Wis., under date of September 17 last.

Manufacturing Notes.

THE Philadelphia Scale & Testing Machine Works of Riehle Brothers are very busy on orders for large and small work. Among recent orders is one for a screw-power testing machine of 100,000 lbs. capacity for Andrews Brothers, at Hazelton, O., and one for a wire-testing machine 10,000 lbs. capacity for the Seymour Manufacturing Company at Seymour, Conn.

THE office of Moffett, Hodgkins & Clarke, engineers and contractors, has been removed from Watertown to Syracuse, N. Y. The branch offices in New York and Chicago will be continued as heretofore.

THE Pennsylvania Railroad Company has made contracts for 39,000 tons of steel rails for next year's delivery, 12,000 tons to be furnished by the Cambria Iron Company at Johnstown; 12,000 tons by the Pennsylvania Steel Company at Steelton, Pa.; and 15,000 tons by the Lackawanna Iron & Steel Company at Scranton. The prices range from $28.50 to $30 per ton at mill. The Union Pacific Company has also recently made contracts for 40,000 tons of steel rails for next year, the order being divided among several mills.

AT the Oliver Oil Company's mill at Charlotte, N. C., there is a 65 H. P. Westinghouse engine which has been operated night and day (starting 12 o'clock Sunday night and stopping 12 o'clock Saturday night) for five years, and during that time it has not cost $5 for repairs, and the mill has never stopped a minute on account of the engine.

THE Homestead Steel Works of Carnegie, Phipps & Company recently completed and shipped a lot of steel ties for the Chicago & Western Indiana Railroad.

IN October last the Westinghouse Machine Company, Pittsburgh, sold 30 "Junior" engines, aggregating 935 H.P., 16 standard engines of 645 H.P., and 30 compound engines of 2,510 HP.; a total of 76 engines, aggregating 4,090 H.P.

THE Pond Engineering Company, St. Louis, reports recent sales as follows: For electric lighting, a 50 H.P. Armington & Sims engine to Kansas City; for Joliet, Ill., three 100 H.P. boilers, one 250 H.P. Lane & Bodley Corliss engine, with Hoppes live steam purifier, Lowe heater, pump, injector, etc.; for the State Capitol at Austin, Tex., a 70 H.P. engine and complete plant. For electric railroad work, two Armington & Sims engines of 150 and 70 H.P., with the necessary pumps, heaters, etc., for the Northeast lines, Kansas City; one 125 H.P. engine and complete plant for Laredo, Tex. For other purposes, four 90 H.P. boilers to the cable railroad at San Diego, Cal.; two 150 H.P. boilers for the St. Louis Smelting & Refining Works; one 100 H.P. Lowe heater to Charleston, S. C., for the Palmetto Brewing Company.

AT the works of the Armington & Sims Engine Company, in Providence, a large addition is now under construction. The new building will be filled with machine tools which have already been ordered from the firms of Manning, Maxwell & Moore, New York; Nicholson & Waterman, Providence, and the Pond Machine Tool Company, Plainfield, N. J. A full equipment of traveling cranes and special tools will be provided, and when the addition is completed the works will have a capacity of 150 H.P. of engines per day. A new development at these works is a triple-expansion engine of 250 H.P., now under construction. This engine will have four cylinders arranged in two pairs tandem, the high-pressure and the intermediate cylinders at the rear and two low-pressure cylinders in front. By this arrangement the additional expansion is obtained, while the special features in relation to balancing, etc., of the compound engine, will be retained.

OBITUARY.

JOEL BARLOW MOORHEAD, who died in Philadelphia, October 25, aged 76 years, was born in Dauphin County, Pa., and when only 18 years old took a small contract on the building of the Pennsylvania Canal, and thereafter for a number of years was employed as contractor for railroads, bridges, and other improvements in Kentucky, Indiana, and Pennsylvania. For a short time he was Superintendent of the old State Railroad from Philadelphia to Columbia. He was one of the originators of the Monongahela Improvement, and did most of the work on the locks and dams of that river. His last contract was for the building of the Philadelphia & Erie Railroad. In 1857 he gave up his contracting business, and has since been engaged in the manufacture of iron.

DR. JAMES PRESCOTT JOULE, who died at his residence near Manchester, England, October 10 aged 71 years, was known as one of the most profound and original students of Physics. He was a pupil of the great chemist Dalton, and followed up his investigations besides originating others of his own. He was most widely known from his investigations into heat and electricity, the results of which have been very largely accepted by scientific men all over the world. For a number of years past he has been considered the highest authority on the subjects which he studied.

PERSONALS.

R. A. BRIGGS has resigned his position as Chief Engineer of the Denver & Rio Grande Railroad.

JOHN WEATHERSTON has been appointed Roadmaster of the Detroit Division of the Grand Trunk Railway.

F. HUFFSMITH is now Master Mechanic of the International & Great Northern Railroad, with office at Palestine, Tex.

JOHN F. O'BRIEN has resigned his position as General Manager of the Mexican National Railroad, and will return to the United States.

C. P. MATLOCK has been appointed Resident Engineer of the International & Great Northern Railroad, with headquarters at Palestine, Tex.

CAPTAIN W. T. ROSSELL, U. S. Engineers, has been assigned to duty as Assistant to the Engineer Commissioner of the District of Columbia.

WILLIAM HUNTER has been appointed Engineer of Maintenance of Way of the Central Railroad of Georgia. He was recently on the Atlanta & West Point Railroad.

M. E. SCHMIDT has established an office in Chicago—at No. 1138 Rookery Building—as Engineer and Contractor. He will pay special attention to the introduction of the Abt rack-rail system.

D. PRATT WRIGHT has withdrawn from the old and well-known firm of Whittlesey & Wright, patent solicitors, of Washington. The business will be continued by Mr. G. P. WHITTLESEY.

H. C. POTTER, who resigned the position of General Manager of the Flint & Père Marquette Railroad in August, 1888, has now returned to that road and will hereafter have charge of its business and operations as Vice-President and General Manager.

HENRY S. MARCY has been chosen Vice-President and acting General Manager of the Fitchburg Railroad. The office is a new one, and it is understood that Mr. Marcy is to be the active manager, relieving President Phillips, who will retire on account of his health.

WALTER S. PHELPS, late Master of Machinery of the Ferro-Carril de Guantanamo, Cuba, has resigned that position and has taken charge of the machinery on the large sugar estates of San Miguel, Confluente and San Yldefonso, near Guantanamo, having also charge of the light railroads, locomotives, cars, etc., on these estates for the firm of Bueno & Company.

MARSHALL M. KIRKMAN has been chosen second Vice-President of the Chicago & Northwestern Railroad Company. He will continue to have charge of the accounting department of that company, which has been under his control for so long. Mr. Kirkman has a very high reputation as a railroad accountant, and his books on the subject are standard authorities.

NATHAN GUILFORD has been recommended by the Committee of the Trunk Line Association for the position of Trunk Line Commissioner in place of General Albert Fink. Mr. Guilford has had a wide experience on the Baltimore & Ohio and other railroads, and was for some time Mr. Fink's Assistant. The recommendation of the Committee has not yet been acted upon by the Association.

FREDERICK E. SAWARD, Editor of the *Coal Trade Journal*, has been appointed a member of the General Committee of the International Exposition of 1892 in New York, as a representative of the Coal Trade. Mr. Saward is eminently qualified for the position, not only as a representative of a very important industry, which no one knows more thoroughly than he, but also as a man of great energy and activity, who is certain to be a valuable member of the Committee.

PROCEEDINGS OF SOCIETIES.

Railway Telegraph Superintendents' Association.—The eighth annual meeting was held in Washington, October 16 and 17, with a large attendance. The following officers were elected: President, C. A. Darlton; Vice-President, George T. Williams; Secretary and Treasurer, P. W. Drew. Niagara Falls was chosen as the place for the next meeting.

The time on the first day was mostly taken up by an elaborate paper on Electric Lighting of Trains, by Mr. Charles Selden, of the Baltimore & Ohio, and by discussion on this paper.

On the second day there were reports and discussions on Cipher Codes, on Night Messages, on the Train Telegraph and several other subjects. A discussion on the Block System was postponed until the next meeting.

American Street Railroad Association.—The eighth annual meeting began in Minneapolis, Minn., October 16, with a large attendance. Eight additional companies were admitted to membership. The President delivered the opening address, after which the Executive Committee presented a long and elaborate report. The Treasurer presented a report showing that the Association was in good financial condition. Reports were presented by the Committee on Mutual Insurance and also by the Committee on Employés' Relief Associations, the latter giving rise to considerable discussion.

The evening session was devoted to a report on Electricity as a Motive Power, the main point in the report being a discussion of the financial results obtained on electric railroads. This called out a very long discussion and many differences of opinion.

The second day a report was presented on Motors for Street Railroads, which was a long and careful discussion of the experience had with motors other than animal and electric. The conclusion reached was that, while the cable-road is the best plan yet adopted where the traffic is large, there is a broad field still open for the adoption and use of some practical and economical motor for railroads whose business is not large enough to warrant the expense of a cable plant.

A report was presented on the Care of Horses which was thoroughly discussed, and another report on Public Sentiment toward Corporations.

Buffalo was chosen as the place for the next Convention, and the following officers were chosen for the ensuing year: President, Thomas Lowry; Vice-Presidents, C. Densmore Wyman, J. C. Schaffer, and Robert McCulloch; Secretary and Treasurer, William J. Richardson; Executive Committee, George B. Kerper, George W. Kiely, Raphael Semmes, Frank H. Monks, and F. M. Eppley. The Convention was closed in the evening by the annual banquet.

Master Car-Builders' Association.—The following is the list of subjects upon which reports are to be presented to the Convention of this Association next year, with the names of the Committees to whom has been assigned the duty of preparing the reports.

1. Journal-box, Bearing, and Lid for 60,000-lbs. Cars, and Lid for old Standard Journal-box: Committee, John S. Lentz, F. D. Casanave, R. McKenna, J. N. Lauder, A. A. Jackson.
2. Metal for Brake Shoes: G. W. Rhodes, B. K. Verbryck, E. B. Wall.
3. Lettering Freight Cars: E. W. Grieves, G. W. Demarest, R. D. Wade.
4. Steam-Heating and Ventilation of Passenger Cars: J. N. Barr, T. A. Bissell, J. W. Marden, J. C. Barber, W. H. Lewis.
5. Steel Plate and Malleable Iron in Car Construction: William Forsyth, John MacKenzie, E. D. Brónner.
6. Code of Rules for Interchange of Passenger Equipment Cars: C. A. Schroyer, R. Kells, J. H. Rankin, J. B. Henney, T. Sutherland.
7. Loading Bark and Logs on Cars: R. C. Blackall, William McWood, F. D. Adams.
8. On Expediency of a Change in Standard Height of Drawbars in Passenger Equipment Cars: E. D. Nelson, John Kirby, H. Middleton.
9. On Place of Meeting in 1890: R. D. Wade, W. H. Day, G. W. Demarest.

Northwest Railroad Club.—At the meeting in St. Paul, November 9, Mr. Griffin read a paper on Car-Wheels, discussing the comparative merits of the common chill and the contracting chill for making cast-iron wheels. This paper called out a long discussion between Mr. Griffin, Mr. J. N. Barr, and others.

Central Railway Club.—A regular meeting of this Club was held in Buffalo, October 23, which was mainly devoted to discussion of proposed amendments to the Master Car-Builders' Rules of Interchange. A committee was appointed to suggest changes which may be advisable.

The Committee appointed to report on Coal Consumption and Economical Appliances asked for further time, and was given until the January meeting.

Western Railroad Club.—At the regular meeting in Chicago, November 19, the first subject was Compound Locomotives. This was opened by a paper read by E. W. M. Hewes, in which he described the methods employed by him on the Indian State Railroads, in changing simple to compound locomotives.

The second subject was the Best Metal for Brake-Shoes, which was opened by an account given by Mr. E. C. Case of experiments made by him on the St. Louis & Hannibal Railroad. Both papers were discussed by members present.

American Society of Mechanical Engineers.—The programme for the fall meeting of this Society, which began in New York, November 18, was as follows:

On Monday evening the meeting was opened by a reception at the rooms of the Society, No. 64 Madison Avenue. This was intended not only as an opening of the Convention, but as a sort of house-warming for the new rooms and library.

On Tuesday the programme included sessions for general business and for the reading of papers in the morning and afternoon, and in the evening the annual subscription dinner of the Society.

Wednesday was devoted to excursions to various points of interest. In the evening a reception was tendered to members by the Engineers' Club.

On Thursday there were morning and afternoon sessions for the reading of papers and discussion, and in the evening members visited the American Institute Fair.

On Friday there was a session, in the course of which a paper on the Performance of the Double-screw Ferry-boat *Bergen*, of the Hoboken Ferry, by Colonel E. A. Stevens and Professor J. E. Denton, was read.

Among the papers announced for this meeting were the President's Address, by Henry R. Towne; Philosophy of Compound Engines, by Professor R. H. Thurston; Cost of Lubricating Car-Journals, by L. S. Randolph; Rolling Steel Rails, by Dr. R. Nicholson; Indicator for Compound Engines, by F. W. Parsons; Transmission of Force in the Steam-Engine, by D. S. Jacobus; Cost of Steam and Water Power, by C. T. Main; and a number of others of interest.

American Society of Civil Engineers.—At the regular meeting in New York, November, 6, a committee was appointed to respond properly to the address received from the Institution of Civil Engineers in relation to the visit of American engineers to England last summer. The matter of arranging jointly with the Mining and Mechanical Engineers for entertaining the British Iron & Steel Association next year was referred to the Board.

The Committee on Revision of the Constitution submitted a report noting the progress which had been made in its work. The work was accepted, and the Committee continued to report at the annual meeting in January.

The tellers announced the following elections:

Members: B. W. De Courcy, Port Townsend, Wash.; John Q. Jamieson, Portland, Ore.; William W. Kenly, Wilmington, Del.

Juniors: William F. Behrens, Albuquerque, N. M.; M. C. Hamilton, Hartford, Conn.; George W. Sherwood, Bethlehem, Pa.

Mr. C. E. Emery then read a paper on a Visit to the Forth Bridge, and Reminiscences of the Trip to Europe, which was discussed by members present.

Engineers' Club of Philadelphia.—At the regular meeting, October 19, the Secretary presented, for Mr. Conway B. Hunt, a very complete description of Repairing a Bridge Pier Foundation. These repairs were made to what is known as Pier No. 1 of the Aqueduct Bridge over the Potomac River. The rock bottom of the river is from 25 ft. to 35 ft. below low tide. After an extraordinary freshet a settlement was discovered, and investigation showed that a cavity had been scoured under the pier, extending the full length of the pier and across its upstream end. This cavity was about 4 ft. high and extended about 6 ft. back under the pier. The Author then gives a very

full description of the manner in which this pier was constructed, from which it appears that all of the masonry had not been extended to the rock. After the first settlement was observed it was found to continue, and repairs were at once begun. These were made by lowering concrete in loosely filled bags, which were packed in the irregular cavity by divers, and by lowering concrete in tubes, which were tripped and the material pushed with hoes and special tools into all the remaining portions of the cavity, until it was completely filled with a substantially solid mass of concrete. The outer surface of the pile of bags was finished with loose concrete. The method of preparing the concrete and doing the work is then described. The repairs occupied about 11 working days, and about 110 cubic yards of concrete were used. The total cost of the work was $3,112 ($28.28 per cubic yard); this does not include $1,394 additional spent for rip-rap. There was some discussion of kindred subjects by Messrs. E. H. Brown, Howard Murphy, and Professor L. M. Haupt.

At the regular meeting in Philadelphia, November 2, the Secretary presented, for Mr. Edward Hurst Brown, a description of Driving Piles by Water.

There was some discussion by Mr. Frederic Graff and Professor L. M. Haupt.

Mr. P. F. Brendlinger presented a very full and illustrated description of the Grout Pump and Methods of Grouting the New York Aqueduct.

There was an extended general discussion of matters concerning this engineering structure.

Boston Society of Civil Engineers.—At the regular meeting, October 16, F. W. Dean, B. R. Felton, and George J. Leland were elected members. The Committee to confer with the American Society of Civil Engineers reported progress.

The rest of the meeting was devoted to the presentation by members of their notes and experiences gathered during the trip of the American Engineers to Europe last summer.

Engineers' Society of Western Pennsylvania.—At the regular October meeting, James O. Handy was elected a member. A committee was appointed to prepare a suitable memorial of the late Captain William R. Jones.

Mr. I. S. McGiehan read a paper on the Standard Metal Tie, giving an account of experience with metal ties in Europe and this country. The paper was discussed by Messrs. Hunt, Hibbard, Swensson, Davison, Thaw, and Verner.

Michigan Engineering Society.—The officers of this Society, elected by letter-ballot for the ensuing year, are as follows: President, R. C. Carpenter, Lansing; Vice-President, J. H. Forster, Meridian; Secretary, F. Hodgman, Climax; Directors, George E. Steele, M. E. Cooley, Charles E. Greene.

The annual meeting for 1890 will be held in Detroit in the third week in January. The Society now numbers 135 members, including the most prominent civil, mechanical, and mining engineers in the State. It is incorporated under a special act of the Legislature and issues each year a valuable annual.

Engineers' Club of Cincinnati.—The fifteenth regular meeting of the Club was held October 24, with 10 members present.

A committee of three was appointed to confer with the committee of the American Society of Civil Engineers in relation to the proposed uniting of the various Engineering Societies of the country.

In the absence of any prepared paper for the evening the members discussed the accident which occurred recently at the inclined plane extending to one of the hill-tops in Cincinnati, by which several lives were lost. The proper connection of cable to car, the use and reliability of various clutch and brake devices, etc., were discussed at some length and proved interesting and instructive.

Engineers' Club of St. Louis.—At the regular meeting in St. Louis, October 23, John Dean was elected a member. The Secretary read a letter from the Chairman of the Board of Managers of the Association of Engineering Societies, proposing a meeting of the Board to consider the question of proposed affiliation with the American Society of Civil Engineers.

Mr. H. A. Wheeler then presented some notes regarding the recent European trip of the American engineers. Some 300 members of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Institute of Mining Engineers took part. Mr. Wheeler gave full particulars of the trip.

The special order of the day was the securing a permanent place of meeting. After discussion a committee was appointed to consider the subject.

Mr. Johnson exhibited a test piece of iron, which had been welded by the electrical process at the Exposition.

At the regular meeting in St. Louis, November 6, the Committee on Location recommended that the Club rent rooms in the Laclede Building. The report was approved, and the Executive Committee authorized to lease a room and furnish it. Mr. Winthrop Bartlett read a paper on the Olive Street Cable Railroad. The total length of this road is 9.6 miles, the conduit is 39 in. deep; the Johnson rail, weighing 65 lbs. to the yard, is used. The percentage of power required to drive the cable alone is low for a road of this class The fluctuations in the power required are very great, as was shown by an indicator card in which the power varied from 136 to 609 H.P. within one minute. The paper was discussed by members present.

Western Society of Engineers.—At the regular meeting in Chicago, October 2, Mr. Cope Whitehouse read a long and interesting paper on Irrigation in Egypt. Mr. Whitehouse also gave his theory of the Pyramids, which he considered as monoliths cut down from conical hills originally standing on the spot, and then reveted with the rock obtained in the process of cutting.

Engineers' Club of Kansas City.—At the regular meeting, October 7, a paper presented by Messrs. Waddell and Jenkins described tests made in St. Louis on specimens of Phœnix Stone for freezing, absorption, fire, abrasion, crushing, specific gravity, together with a microscopic analysis, the results on the whole indicating a very superior stone.

The Club is indebted to the Phœnix Stone Company for samples of their stone, together with a handsome table for the Club.

At the regular meeting in Kansas City, November 4, John R. Braidwood and Robert M. Sheridan were elected members and Thomas H. Ashburner an associate member. Charles H. Hastings was chosen Librarian in place of F. Allen, resigned.

The paper on Building Stone, read October 7, was discussed. Short papers on Sewer Ventilation, by F. E. Sickels, and on Sewerage Disposal, by K. Allen, were read and discussed.

Papers by Professor L. M. Haupt and John Willett, on an Outer Harbor off Padre Island, Tex., were also read and discussed. The plan for the harbor includes the building of an iron pier out into the Gulf, 4,500 ft. from shore.

Montana Society of Civil Engineers.—At the October meeting in Helena, Mont., a report was received from the Committee on Irrigation. The Committee on Public Land Surveys was requested to report at the next meeting. The Committee on Relations with the American Society of Civil Engineers recommended that action be deferred, and a special Committee appointed to confer with the American Society and with the local engineering societies. This action was taken.

Colonel De Lacy read a paper on the History of Public Land Surveys, and suggests the abolition of the present system, and the adoption of an entirely new system with a special call of land surveyors.

Franklin Institute.—The programme for the month of December includes lectures on the following subjects: December 2: Chemistry, by Professor C. H. Henderson; December 6: The Optical Lantern as a Means of Demonstration, by F. E. Ives; December 9: Emery-Wheels, by Dunkin Paret; December 13: Duty of Pumping Engines, by William M. Barr; December 16: Electricity, by Ralph W. Pope; December 20: Cost of a Steam Horse-Power, by Thomas Pray.

New York Railroad Club.—The first regular meeting of the season was held October 21. The subject for discussion was Journal Bearings. It was opened by Mr. George R. Menedy, who read a long paper, giving the history of many experiments and trials, and an account of tests made of the roller bearings invented by him, which showed a very excellent result. The paper was discussed by members present.

NOTES AND NEWS.

Petroleum in Burmah.—Some surveys of the petroleum deposits in Burmah have been made by the Indian Geological Survey, and it is stated that the working of these deposits has so far been carried on in a very imperfect way and without system. The deepest wells used are from 250 to 300 ft., and these leave untouched fully 100 ft. of the oil-bearing sandstone. When proper methods and sufficient capital are employed, there is little doubt that these oil deposits can be profitably worked and will yield largely, and the officers of the survey believe that from them the demand in India can be fully supplied, with probably a surplus for export to other eastern countries.

German Canals and Water-ways.—The Rhine, on a navigable length of 435 miles, has a yearly traffic of 5,500 vessels averaging 200 tons each, ranging from 386 vessels of 50 tons to 14 of 1,300 tons. On the Danube the number of vessels is about 800, ranging from 75 to 525 tons, average 200 tons. On the Elbe the number is 9,400, average tonnage, 106. From Vienna there may be reckoned three great water-ways: (1) The Danube; (2) the Danube-Oder Canal, giving communication with Prussia; and (3) the projected connection from this canal to the Elbe.

On the Danube the westward limit of navigation is at present Regensburg, 281 miles from Vienna, although it is probable that the channel as far as Ulm, 131 miles further, is well suited for chain-traction. Connection could be made with the Rhine in either of two directions: firstly, from Dillingen, about 31 miles below Ulm, *viâ* Königsbronn (1,640 ft. above sea-level) to the Neckar, and from Cannstadt to Mannheim; and secondly, by Kehlheim, Nürnberg and Bamberg (1,375 ft.) to the Main, and thence from Frankfort to Mainz.

The canalization of the Main from Frankfort to Mainz has been attended by the most noteworthy commercial results, in spite of the unfavorable dry season following the completion of the work. The saving of freight on goods to and from Frankfort has amounted to $185,000, and to other places between the terminal points $98,000. The saving on coal freight alone has paid 6 per cent. on the Frankfort Harbor Works.

On the 46.5 miles length of the Rhine between the Main and the Neckar there are the following river ports and commercial landing places:

Port.	Trade.	Total Length of Landing Places.	Average Tonnage per Mile.
	Tons.	Miles.	
Frankfort	654 000	4.4	148,500
Gustavsburg	427 000	1.0	402,500
Mainz	202,000	9 9	21,000
Mannheim	1,796,000	12.4	145,000
Ludwigshafen	647 000	1 9	348,000
Total	3 726,000	29.6	125 870

The traffic of this district is capable of immense development.

A canal is now projected from Strasburg to Ludwigshafen, which would make Strasburg a western central point of European inland navigation, as Vienna must be the central point for Eastern Europe.—*Wochenschrift des Oesterreichischen Ingenieurs Vereines.*

The Casalmaggiore Bridge.—This bridge consists of 17 spans, of which those at each end are 180 ft. and the other 15 are 213 ft. each, the total length between the abutments being 3,560 ft. The piers and abutments were founded by means of compressed air at depths varying from 65 to 85 ft.

The bridge is for a single track, the load being on the bottom chord. It is formed of two parallel continuous lattice girders fixed upon the eighth pier, and supported on rollers on the other piers and abutments. The river, when not in flood, is 1,312 ft. wide, and a temporary bridge of timber was built over this width for the carriage of materials. Near one of the abutments shops were erected for the engines, air-compressors, pumps, dynamos, repairs, smithies, stores, and offices. After the first 10 supports had been built, these shops and their contents were transferred to the other side of the river. The air-compressors were driven by two semi-fixed engines of 35 nominal H.-P. each, and one of 10 H.-P., the latter being used for shallow depths.

The whole of the compressed-air foundations were completed in 14 months, during two of which work was suspended on account of the cold. The material excavated, which was almost entirely of a sandy nature, was thrown by the workmen into a chest about 1 ft. 8 in. square, and 2 ft. 8 in. high, into which water was pumped through a pipe so as to mix with the sand. The mixture was then forced out through another pipe, in an almost continuous stream, by the pressure of the compressed air in the chamber. By this means a volume of about 130 cubic yards, in the proportion of one-third of sand and two-thirds of water, was forced out in 24 hours. The working chambers were lighted by electric lamps continuously, and during the night the temporary bridge and the whole of the shops were also lighted, there being in all 50 Edison lamps of 6-candle power each, driven by a 4 H.-P. (nominal) portable engine. The total depth of foundation amounted to 1,312 ft., and was executed in 383 working days of 24 hours. There was no considerable flood in the river during this period.

The calculations for expansion and contraction were based on the assumption that the temperature would range from 14° to 104° Fahrenheit, and that the difference in temperature between the top and bottom flanges, owing to the top being in the sun and the bottom in shade, might amount to 22°. This difference might be disregarded in a single-span bridge, but in the case of eight or nine continuous spans it must be considered, owing to the fact that it will have a tendency to throw the uprights out of the vertical, and strains will be brought upon the flanges in resisting this.

This bridge carries the Parma-Brescia Railroad over the River Po, at Casalmaggiore, Italy.

Haulage Resistance in Channels of Limited Dimensions.—Where the channel is sufficiently deep and broad, it is, as a general rule, advisable to convey goods in as few vessels as possible, as the number of vessels among which a given cargo is distributed materially affects the extent of the dead load, and increases the resistance. The Author remarks, however, that this does not always hold good with water-ways of more limited depth and width, where the relation between the sectional areas of the channel and of the boat has to be taken more closely into account.

For instance, a tug traveling at the rate of five miles an hour will, with certain dimensions of channel, haul a load of 205 tons on one vessel, or of 260 tons if the cargo is distributed over two boats. The author discusses at length the varying conditions of velocity and resistance, the results being briefly expressed below. In these tables T = depth of water in feet, F = sectional area of water-way in square feet, n = sectional area of water-way ÷ submerged sectional area of vessel, and N = total resistance.

In the case of the 205-ton load on one vessel, with draft area of 74.8 sq. ft.:

T.		*F.*	*n.*	*N.*
Ft.	Ins.			
4	0	430	5.76	62
4	3	754	10.07	35
4	6½	1 015	14.40	30
4	8	1,400	18.70	28
4	9½	1,720	23.02	27

With 260 tons distributed over two vessels, draft area = 54.7 sq. ft.:

T.		*F.*	*n.*	*N.*
Ft.	Ins.			
4	0	430	7.87	50
4	3	754	13.78	37
4	6½	1,015	19.68	34
4	8	1,400	25 59	32
4	9½	1,720	31.50	31

It will be seen that with the smaller channels the resistance is less in the case of the two coupled boats than in the one larger vessel, but that, as the water-way increases, this relation is reversed. It will, therefore, be found that at one point—that at which F = 645 sq. ft., and N = 39, with a depth of 4 ft., the same power will haul either 205 tons on one boat or 260 tons on two smaller boats, at the rate, in either case, of 5 miles per hour. Where the proportion n (see Table 1) = 5.76, the resistance is 2.7 times greater than where the water-way is practically unlimited, while where n = 31.5 (see Table 2) it is only 1.12 times greater.—*Zeitschrift des Vereines Deutscher Ingenieure.*

The First Iron Works in America.—An interesting article by Mr. Nathan M. Hawks in the *Magazine of American History* for November gives an account of what is claimed to be the first iron works in America. A company or association was formed in Lynn, Mass., in 1642, to work the iron ore which was found on the banks of the Saugus River, and this company established a village called Hammersmith near the place where the ore was found. In 1649 it was stated that the works were making about seven tons a week and they had then been running for six years, active operations having been begun in 1643. A charter, with exclusive privileges of making iron in the Colony, was granted by the General Court in 1645. These iron works continued to flourish until about 1688 or 1690, when they were discontinued, for what reason does not seem to be exactly known, although litigation with the landowners over damages to their property had apparently something to do with it, and doubtless the discovery elsewhere of iron ore, which could be better and more cheaply worked, had also its influence. The works embraced a blast furnace or foundry, as it was called, and a refining forge, and do not seem ever to have exceeded the product mentioned, about seven tons a week.

A New Ship Railroad.—A ship railroad devised by William Smith, of Aberdeen, Scotland, on what he calls the flexible-car system, was recently described by him to the Liverpool Chamber of Commerce. He said that the object of his invention was: 1. To keep a ship of any dimensions water-borne upon the car, with a uniform pressure over the skin of the ship upon a film of water forming a small percentage of its weight. 2. To make the car sufficiently flexible to admit of the usual railroad gradients. 3. To make the wheel-base sufficiently flexible laterally to admit of curves, switches, crossings, and passing places on the multiple ship railroad. These results, he said, had been successfully attained by the contrivances of hydraulic cushions, sectional cars, with adjustable sides, and the compound bogies, or trucks.

Comparing ship railroads with ship canals, the average cost per mile of which was $1,000,000, through the most favorable description of country, he said the flexible-car ship railroad would only cost $300,000 per mile.

A ship railroad on the rigid-car system would, he said, cost $400,000, and would not be nearly so efficient. A railroad on this latter system is in course of construction at Chignecto, N. S. If it proves a success there is obviously a great future before the ship railroad on one plan or the other. The whole thing is so much out of the range of practical experience, that nothing will settle the question of its practicability, except such an experiment as that now in preparation at Chignecto.—*Nautical Magazine.*

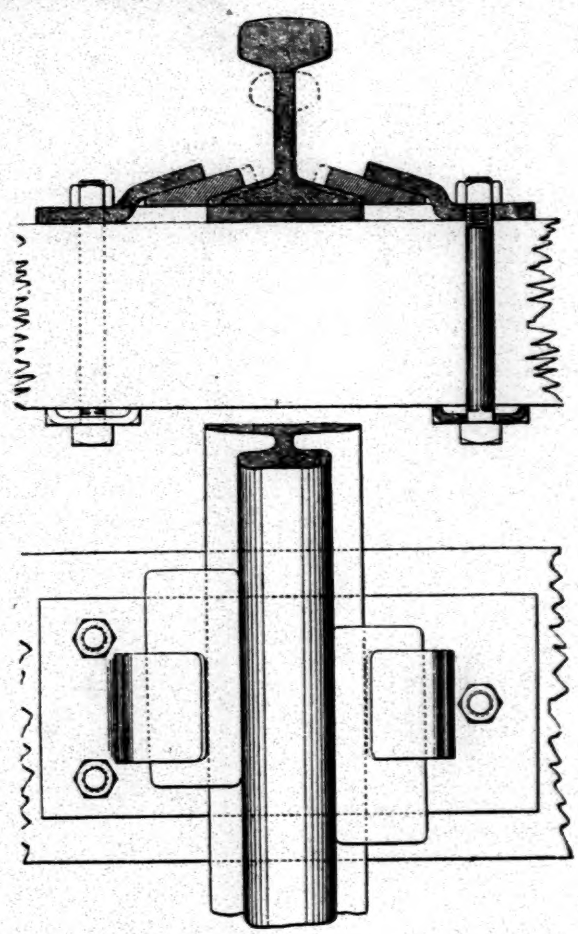
Electric Lighting of Trains.—At the recent meeting of the Telegraph Superintendents' Association, Mr. Charles Selden, of the Baltimore & Ohio, read an interesting paper on the Electric Lighting of Trains. After giving a short sketch of what had been done, he said that there were three systems of lighting cars: By joint use of a dynamo and storage battery; by means of a dynamo and direct current; and by charged storage batteries. The first system is in use by the Pullman Company upon the limited New York-Chicago trains; on the vestibule trains of the Atchison, Topeka & Santa Fé, and some others. In this system a Brotherhood engine directly connected with the dynamo is placed in the baggage car, the engines being supplied with steam from the locomotive boiler. Each car carries in a box under the bottom of the car 32 cells of storage battery, and under the system of distribution this storage battery is partly in use at all times, furnishing, when the dynamo is running, about 30 per cent. of the power given to the lamps, and, when the dynamo is not running, all the power. The weight of the storage battery and box is about 1,300 lbs. per car. During the day or at other times when the lines are in use the dynamo is run long enough to charge these batteries, so that it is not necessary to remove them from under the car for a considerable time. This system requires the service of a special attendant, who is experienced in electric lighting, and who, in the case of the Pullman train, is paid $90 per month.

The system of lighting direct from a dynamo, without the use of a storage battery, is not now in use, but, in the opinion of the writer, could be advantageously employed, saving the expense of the batteries. The objection is that, in case of any failure either in the engine, dynamo, or connections, the lights would go out; but this he does not think a serious one.

The third system of lighting, by storage batteries entirely, the batteries being charged at the terminus, is in use on the Pennsylvania Railroad, the Boston & Albany, and some others. The expense of this system is not stated.

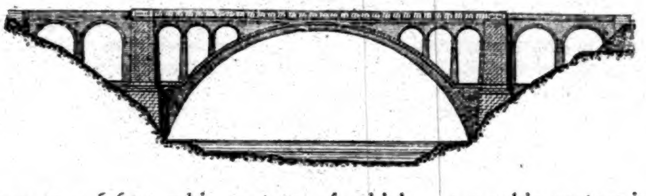
The paper gives the following as the cost of a plant for a single train, approximately: Baggage car, including engine and dynamo, $1,840; mail car, $427; two day-coaches, $462 each; sleeping car, $504; dining or parlor car, $487; total, $4,182. The cost per year for a train consisting of a baggage, two ordinary cars, and two sleeping cars would be: Depreciation of plant, $770; interest, $208; service of attendant, $1,080; total, $2,058. This system makes no allowance for the cost of the steam furnished from the locomotive. On the basis of 365 days of 10 hours each, the cost per day would be $5.64 for a train, or 6.6 cents per lamp per day. These figures have been very carefully prepared, and it is believed that full allowance has been made for depreciation. The cost per day for a sleeping car would be $1.72; for an ordinary car, $0.92; and for a baggage car, $0.33. On this basis, and from the figures given above, the cost for an ordinary train can readily be estimated.

Sandberg's Base-Plate for Rails.—Mr. Sandberg's new heavy rail as last designed has, in addition to a wider head, been modified by adopting a narrow flange with a view to using steel base-plates with it. The width of the flange or foot varies from $3\frac{1}{2}$ in. for a 50 lbs. section up to 5 in. for a 100-lbs. section.



With an 8-in. tie this would give a bearing of from 28 to 40 sq. in. on the tie; but owing to the way in which ties are often cut, this bearing is sometimes considerably reduced. In order to give as much bearing on the tie as is obtained by the double-headed rails and iron chairs used on so many English railroads, and thus to meet the view of English engineers, Mr. Sandberg has designed a steel base-plate 7 × 16 in. in size and $\frac{1}{2}$ in. thick, giving a bearing surface of 112 sq. in. on the tie, offering the same method of fastening—by bolts or wood-screws—as a chair. These are the general dimensions, which, of course, may be modified according to circumstances. Clips are made in the base-plate, as shown in the accompanying illustration, and the rail is fixed to the base-plate by steel keys driven in between these clips and the flange as shown. In this way the tie can be removed without removing the rail, the same as with a chair. Where it is deemed best to set the rail at an angle, as is done on many European roads, it can be obtained in several ways: by cutting the top of the tie, by bending the plate, or by rolling the base-plate of varying thickness. The rail-joint would be suspended by angle fish-plates, which offer sufficient bearing surface on the joint ties, so that the base-plates would only be needed on the other ties. The same plate may be used for rails with flanges from 4 in. to 5 in. wide, the only change necessary being a different size of key. The plate, as designed by Mr. Sandberg, is only 16 lbs. in weight.

The Lavaur Bridge.—The new railroad from St. Sulpice to Castres, France, crosses the Agout River near Lavaur bya masonry arch of 61.50 m. (201.72 ft.) span and 27.50 m. (90.20 ft.) in height. The use of so large a span in this place was warranted by the presence of a very solid foundation; in fact, there stands close by, and resting upon substantially the same ground, a very handsome masonry arch built in the eighteenth century, and having a span of 48.73 m. (159.83 ft.) and height of 19.49 m. (63.93 ft.). Upon the flank of the large arch are several smaller arches of 450 m. (14.76 ft.) opening. These smaller arches are backed by two heavy piers of stone, which are connected with the abutments on either side by two arches of 8 m. (26.24 ft) opening. The total length of the viaduct is 123.50 m. (404.88 ft.). The actual amount of masonry, including the foundations, was 6,619 cubic metres, of which 4,517 cubic meters is above the surface. The width of the masonry in the arch is 4.80 m. (15.74 ft.).



The material of the large arch is rough stone laid in cement mortar; the piers and upper work are faced with cut stone. In building the bridge two very large cranes were used, which cost about $2,700 each. The construction of the arch occupied 82 working days. The total cost was $97,000, of which $16,200 were spent on the foundations and about $40,000 on the large arch. The false-work, upon which the arch was built, alone cost $7,600. The entire settlement of the arch after the false-work was removed was 0.62 mm. (0.24 in.). The false-work was removed 135 days after the completion of the arch. A sketch of the bridge is shown in the accompanying illustration.

The Largest Sailing Vessel.—*Le Yacht*, in a recent number, gives a detailed description of the remarkable sailing vessel called the *France*, which is now being built in the Russell Yard, at Port Glasgow, for the firm of Bordes & Fils, of Paris and Bordeaux. The *France* will be, it is claimed, the largest sailing ship ever built, her dimensions being: Length over all, 376 ft.; beam, 49.3 ft.; depth, 33.7 ft.; net register tonnage, 3,600 tons. The vessel is built of steel, with double bottom on the cellular system, and will carry water ballast. She will probably be the only sailing ship on the ocean with five masts; of these four will be of the same length and square-rigged. The lower mast and topmast are in one; the after-mast, which is fore-and-aft rigged, is a pole-mast.

Speed of Trains in Europe.—The German technical press is at present discussing the speed of express trains. In answer to petitions addressed to him by a number of persons interested, the Minister of Public Works declared recently that it would be very difficult to respond to demands of this kind, since the speed of express trains on the Prussian railroads was already greater than in any other European country. If it should be increased, the public would not patronize the railroads.

This assertion, it is shown from statistics collected by *Le Genie Civil*, is not by any means correct. The following table shows the average speed of fast trains in different European countries, and shows that Germany does not by any means occupy the first rank:

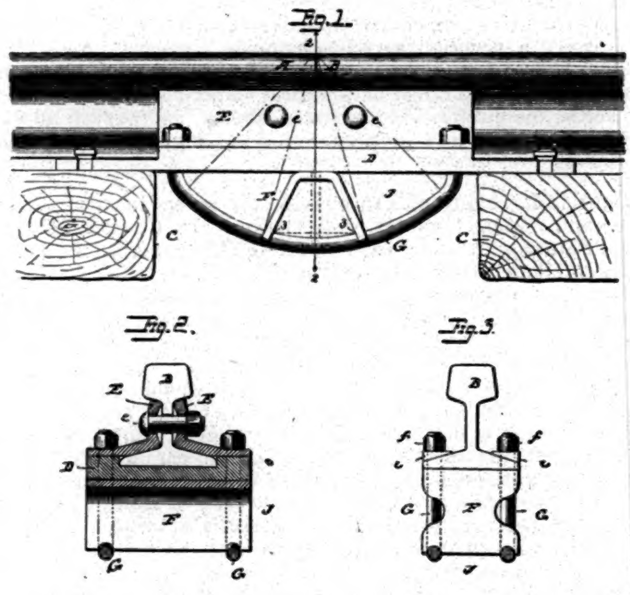
Country.	Speed per hour in miles. Including stops.	Without stops.
Great Britain	41.7	44.6
France	32.8	36.2
Holland	32.5	35.0
Belgium	31.8	33.5
North Germany	31.8	34.3
South Germany	31.2	33.0
Austria-Hungary	30.0	32.0
Italy	29.5	31.8
Russia	29.0	31.7

The inferiority of Germany in this point of view finds a marked expression, if we compare the speed of the great Oriental Express, which runs between Paris and Constantinople, passing over the railroads of a number of European countries, including Germany. This train is the fastest long distance express train run in Europe, and from the time-table the average speed in the different countries is as follows: In France, 40.5 miles per hour; in Germany the speed varies in different sections, being in Alsace-Lorraine, 32.5 miles; in Baden, 35.5 miles; in Würtemberg, 30 miles; in Bavaria, 33.7 miles. In Austria the average speed is 33.5 miles; in Hungary, 34 miles; and in Roumania, 32 miles. This comparison, it will be seen, is not altogether to the advantage of the German lines.

In this connection some comparison may be made of the passenger tariffs in different countries. From this it appears that the lowest charges, both for first and second-class passages, are in Belgium, Holland coming next, then Germany, then France, then Austria-Hungary. England and Italy charge the same fare for first-class passages, but the English second-class is considerably lower than the Italian. The highest fares in Europe are in Russia. Third and fourth-class fares are not included in this system, as those classes of passengers are not generally carried on the fast express trains.

Rail-joint Support.—The accompanying illustration shows a new spring truss support for rail-joints. Fig. 1 is a side view of the device; fig. 2 a section on the line 22, fig. 1; fig. 3 is a section showing a modified form. In these figures *A B* are the rails; *C C* the adjoining ties, and *J* the spring truss. This consists, in addition to the rails or base-plate, of two members *F* and *G*, the latter being the spring member and consisting of one or more curved steel blades or bars suspended below the rails and supporting the other member, *F*, which consists of a plate of wrought iron or steel of an inverted **Λ** shape, the limbs resting on the spring member and the apex below the meeting ends of the rails.

The members of the truss may be in direct contact or connection with the rails themselves, as shown in fig. 3, which represents a construction in which each flange of each rail is perforated for the passage of one of the ends of one of the rods constituting the spring member, each end of each rod being threaded to receive a nut *f*, which bears upon a wedge-like washer *i*, of such a shape as to afford a level bearing for the nut, and the apex of the rigid member *F* is in direct contact with the under sides of the rails. Instead of this construction shown in fig. 3, the other two members of the truss may be indirectly connected with the rails through the medium of a base-plate *D*, suitably bolted or otherwise secured to the rails, and perforated or otherwise formed for the attachment of the spring member of the



truss, and channeled to receive the rails, and resting with its lower face below the meeting ends of the rails upon the member *F*.

As shown in figs. 1 and 2, angle-plates *E E* are used as means of connection between the base-plate and the rails, each angle-plate being secured to the base-plate by bolts, or by means of the rods constituting the spring member of the truss, as shown, and being also secured to the sides of the rails by means of a transverse bolt or bolts *e*.

In the construction shown in figs. 1 and 2 the base-plate is spiked to the ties, and there are two cross-bolts *e*, both passing through elongated openings in the angle-plates, so as to permit expansion and contraction of the rails without strains upon any portions of the truss.

The spring member is composed of metal having a slight elasticity; the curved form is not essential. This invention is covered by Patent No. 413,347, issued under date of October 22 last to the Long Spring Joint Truss Company of Chicago, assignor of Richard Long, now deceased.